Endangered Species Act
Federal Columbia River Power System
2008 Annual ESA Progress Report

Detailed Description of Reasonable and Prudent Alternative (RPA) Action Implementation

Under the second Reasonable and Prudent Alternative (RPA) action, the Action Agencies are required to submit an annual progress report that describes the status of implementation for the previous calendar year. Section 3 describes this progress for each RPA action. Section 4 includes a list of all projects implemented in 2008 along with their associated RPA subactions.

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Hydropower Implementation Reports, RPAs 4–32

This document reports on actions taken during calendar year 2008, which includes the first 7 months of the 10-year Biological Opinion (BiOp) period. The Hydropower RPA actions are intended to be implemented over the term of the BiOp. Although many of these actions were under way or being implemented during 2008, some will be implemented later in the BiOp period. For hydro operations, actions are reported by water year (October thru September) rather than calendar year because this is more meaningful.

Table 1. Hydropower Strategy Requirements

RPA No.	Action	Annual Progress Report Requirement
Hydropower Strategy 1		
4	Storage Project Operations	Prepare an annual year-end review.
5	Lower Columbia and Snake River Operations	Prepare an annual year-end review.
6	In-Season Water Management	Annual progress reports will describe Federal Columbia River Power System (FCRPS) operations for the fish passage season. There is no other physical or biological monitoring or reporting.
7	Forecasting and Climate Change/Variability	Annual progress reports will include a summary of the annual forecast review and any new, pertinent climate change information or research.
8	Operational Emergencies	Annual progress reports will describe any emergency situations and actions taken per the emergency protocols. There is no other physical or biological monitoring or reporting.
9	Fish Emergencies	Annual progress reports will describe any fish emergency situations and actions taken. There is no other physical or biological monitoring or reporting.
10	Columbia River Treaty Storage	Annual progress reports will describe actions taken to provide 1 million acre-feet (MAF) of storage in treaty space. There is no other physical or biological monitoring or reporting.
11	Non-Treaty Storage (NTS)	Annual progress reports will describe actions taken to refill non-treaty storage space. There is no other physical or biological monitoring or reporting.
12	Non-Treaty Long-Term Agreement	Annual progress reports will describe actions taken to develop long-term and/or annual agreements that affect lower Columbia River flows during the April through August period. There is no other physical or biological monitoring or reporting.

Table 1. Hydropower Strategy Requirements

RPA No.	Action	Annual Progress Report Requirement
13	Non-Treaty Coordination with Federal Agencies, States, and Tribes	Annual progress reports will describe actions to coordinate non-treaty storage agreements. There is no other physical or biological monitoring or reporting.
14	Dry Water Year Operations	Annual progress reports will describe actions taken during dry water years. There is no other physical or biological monitoring or reporting.
15	Water Quality Plan for Total Dissolved Gas and Water Temperature in the Mainstem Columbia and Snake Rivers	Annual progress reports will describe actions taken to implement Endangered Species Act (ESA) commitments. There is no other physical or biological monitoring or reporting.
16	Tributary Projects	Status of the consultations for Reclamation's tributary projects will be provided in the annual progress reports.
17	Chum Spawning Flows	Annual progress reports will describe in-season water management actions taken during the water year, which includes part of the previous calendar year.
18	Configuration and Operational Plan for Bonneville Project	Annual progress reports will describe status of the actions taken in the Configuration and Operational Plan (CO)P and the results of the associated research, monitoring, and evaluation (RME).
19	Configuration and Operational Plan for the Dalles Project	Annual progress reports will describe the status of the actions taken in the COP and the results of the associated RME.
20	Configuration and Operational Plan for John Day Project	Annual progress reports will describe the status of the actions taken in the COP and the results of the associated RME.
21	Configuration and Operational Plan for McNary Project	Annual progress reports will describe the status of the actions taken in the COP and the results of the associated RME.
22	Configuration and Operational Plan for Ice Harbor Project	Annual progress reports will describe the status of the actions taken in the COP and the results of the associated RME.
23	Configuration and Operational Plan for Lower Monumental Project	Annual progress reports will describe status of the actions taken in the COP and the results of the associated RME
24	Configuration and Operational Plan for Little Goose Project	Annual progress reports will describe the status of the actions taken in the COP and the results of the associated RME.
25	Configuration and Operational Plan for Lower Granite Project	Annual progress reports will describe the status of the actions taken in the COP and the results of the associated RME.

Table 1. Hydropower Strategy Requirements

RPA No.	Action	Annual Progress Report Requirement
26	Chief Joseph Dam Flow Deflector	Annual progress reports will describe the status of the flow deflector construction. Note: This construction project was completed in spring 2009.
27	Turbine Unit Operations	Annual progress reports are developed by Bonneville Power Administration (BPA).
Hydropower Strategy 2		
28	Columbia and Snake River Project Adult Passage Improvements	Annual progress reports will describe the status of the actions taken.
Hydropower Strategy 3		
29	Spill Operations to Improve Juvenile Passage	Spill operations are reported annually.
30	Juvenile Fish Transportation in the Columbia and Snake Rivers	Annual progress reports will provide the number of fish collected and transported in an annual report each February.
31	Configuration and Operational Plan Transportation Strategy	Annual progress reports will describe the status of the construction and operational actions and associated RME to support the transportation strategy.
Hydropower Strategy 4		
32	Fish Passage Plan	Not applicable.
Hydropower Strategy 5		
33	Snake River Steelhead Kelt Management Plan	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.

Hydropower Strategy 1 (RPA Actions 4–27)

RPA Action 4 – Storage Project Operations*: The Action Agencies will operate the FCRPS storage projects (Libby, Hungry Horse, Albeni Falls, Grand Coulee, and Dworshak projects) for flow management to aid anadromous fish. These storage project operations will be included in the Water Management Plan. These projects are operated for multiple purposes including fish and wildlife, flood control, irrigation, navigation, power, and recreation.*

The FCRPS storage projects were operated in compliance with the 2008 Water Management Plan (WMP, at http://www.nwd-wc.usace.army.mil/tmt/documents/wmp/2008/final/wmp_final_20080402.pdf), which was developed in the fall of 2007 with full regional coordination. The 2008 FCRPS BiOp was released in May 2008; however, the court ordered a continuation of 2007 operations in 2008, except for changes needed to accommodate critical research and new structures. For this reason there were differences between the 2008 operations and those required by the 2008 BiOp. Details of the operations of the projects are shown in Figures 1 through 4 and described below. Further discussion of these operations is included

in the minutes of the Technical Management Team (TMT) meeting "Annual Review of Lessons Learned 2008" at *http://www.nwd-wc.usace.army.mil/tmt/agendas/2008/1121min.pdf*

Dworshak Dam

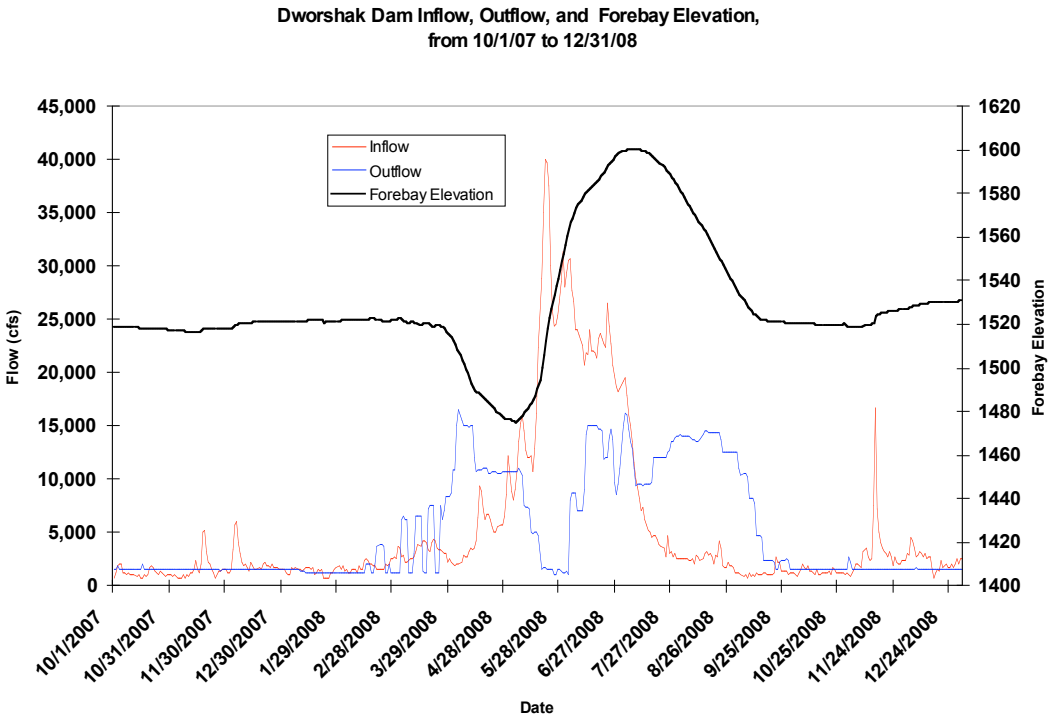

Figure 1. Dworshak Dam Inflow, Outflow, and Forebay Elevation from October 1, 2007, through December 31, 2008.

From October 2007 through February 2008, Dworshak Dam released the minimum flow requirements of approximately 1,500 cubic feet per second (cfs). Beginning in March, discharges were increased because of a 72 thousand acre-feet (kaf) increase in the April through July forecast. By March 30, 147 kaf of system flood control space was shifted to Grand Coulee. The April 1 forecast was 3,010 kaf, or 112 percent of average. To meet the shifted April 15 target elevation of 1,501.4 feet (a shift of 500 kaf), releases were increased to 15,000 cfs April 2 to April 10 and then decreased to power plant capacity (10,400 cfs). The average release for April was approximately 12,000 cfs, and the forebay elevation for Dworshak was 1,476.1 feet on April 30. Dworshak was operated to standard flood control criteria during the winter and spring flood control season.

The start of refill began on May 15, when Dworshak began operating according to Flood Control/Refill Curve procedures. Releases from Dworshak Dam in May averaged 5,000 cfs. The May forecast for the May to July inflow volume was 2,680 kaf, which was 135 percent of average. During April and May, the inflows averaged 5,400 cfs and 21,400 cfs, respectively. Dworshak reached full levels (maximum elevation of 1,599.9 feet) on July 7.

The reservoir began drafting on July 8 to provide temperature and flow augmentation for the lower Snake. Discharges for salmon flow augmentation did not exceed the Idaho state total dissolved gas (TDG) standard of 110 percent. Because of rising temperatures, discharge was increased on July 17 from 9.7 thousand cfs (kcfs) to 12 kcfs. Summer temperature augmentation was successful, maintaining Lower Granite tailwater temperatures below 68 degrees Fahrentheit throughout the summer. The maximum Lower Granite tailwater temperature recorded in 2008 was 67.7 degrees. By

August 31, the reservoir was drafted to elevation 1,535.3 feet, despite a mechanical failure that resulted in loss of the use of Regulating Outlet 2 and limited discharges through the other two regulating outlets. September operations followed the Nez Perce 200 kaf operational plan for 2008, with discharges reduced from 10 kcfs to minimum flows in approximately 2-kcfs increments. The reservoir reached 1,520 feet on September 28.

From October to December, Dworshak released minimum flows of 1,500 cfs, except during brief periods of turbine testing following normal maintenance activities. During all periods when Dworshak was releasing minimum flow, the total dissolved gas was maintained below the Idaho state standard of 110 percent. Winter flood control started on December 15, with Dworshak Reservoir 28.7 feet below the flood control elevation of 1,558.2 feet.

Libby Dam

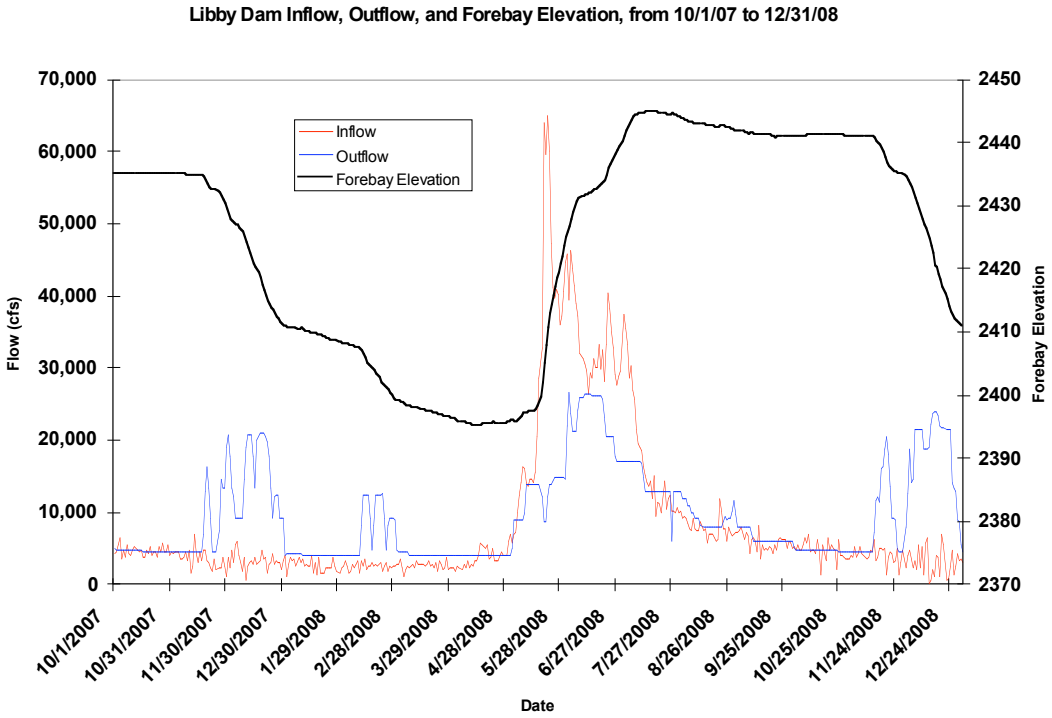

Figure 2. Libby Dam Inflow, Outflow, and Forebay Elevation from October 1, 2007, through December 31, 2008.

From January through April 2008, Libby Dam released the minimum flow of 4,000 cfs, except for February when flows averaged 7,970 cfs. The increase was due to a fairly significant increase in the forecast of 200 kaf. To meet the April 10 target elevation of 2,401.8 feet, Libby operated at the 4,000 cfs minimum, and the forebay elevation for Libby was 2,395.3 feet on April 10.

Libby operated consistent with the variable outflow flood control procedures (VARQ) that were incorporated into RPA Action 4 of the 2008 BiOp. The start of refill was declared on May 15, with outflows averaging 13,500 cfs for the remainder of May. The project was then operated to provide tiered white sturgeon augmentation volumes to achieve habitat attributes for sturgeon spawning/recruitment shaped through coordination with the regional Technical Management Team (TMT) and consistent with the portion of the 2008 BiOp RPA action regarding May, June, and July operations (FWS 2006). The May forecast for the April through August inflow volume was 6,128 kaf,

which set the sturgeon volume at 1.04 MAF and established the tiered bull trout minimum flows from the end of the sturgeon pulse through August 31 to 8,000 cfs. The sturgeon pulse started June 1 and used the entire volume of 1.04 MAF through June 26. The pulse included 14 days at Libby's full powerhouse and an additional 6 days above 20,000 cfs on the descending limb. Libby reached a maximum elevation of 2,444.8 feet on July 17 and technically did not refill. This was due to colder than average temperatures in June for a 2-week period that dropped inflows to Lake Koocanusa and caused some of the headwaters' snowpack to sublimate.

For the remainder of the summer, Libby Dam was regulated to meet the rollover operations based on the 2000 NOAA FCRPS BiOp requirement to draft to 2,439 feet by August 31. The objective was to provide even or gradually declining flows following sturgeon flows during the summer months. This operation was discussed and approved by the TMT. Libby also was used in a swap between Libby Dam and Arrow Reservoir in Canada. The swap enabled Libby to store an additional 120 kaf—or an extra 2.8 feet—on top of the 2,439-foot target by the end of August, which changed the end-of-August elevation target to 2,441.8 feet. On August. 31, the elevation at Libby Dam was 2,441.76 feet. Through September, Libby operated to the minimum bull trout flow of 6,000 cfs.

From October to December 2008, Libby was regulated to meet the projected end-of-December For the remainder of the summer, Libby Dam was regulated to meet the rollover operations based on the 2000 NOAA FCRPS BiOp requirement to draft to 2,439 feet by August 31.[1] The objective was to provide even or gradually declining flows following sturgeon flows during the summer months. This operation was discussed and approved by the TMT. Libby also was used in a swap between Libby Dam and Arrow Reservoir in Canada. The swap enabled Libby to store an additional 120 kaf—or an extra 2.8 feet—on top of the 2,439-foot target by the end of August, which changed the end-of-August elevation target to 2,441.8 feet. On August. 31, the elevation at Libby Dam was 2,441.76 feet. Through September, Libby operated to the minimum bull trout flow of 6,000 cfs.

[1] The operation described here differs from that described in the 2008 NOAA FCRPS BiOp. The 2008 BiOp was released in May, a month following release of the 2008 operation plan by the regional TMT. Therefore, the TMT decided to follow the original 2000 BiOp guidance.

Grand Coulee

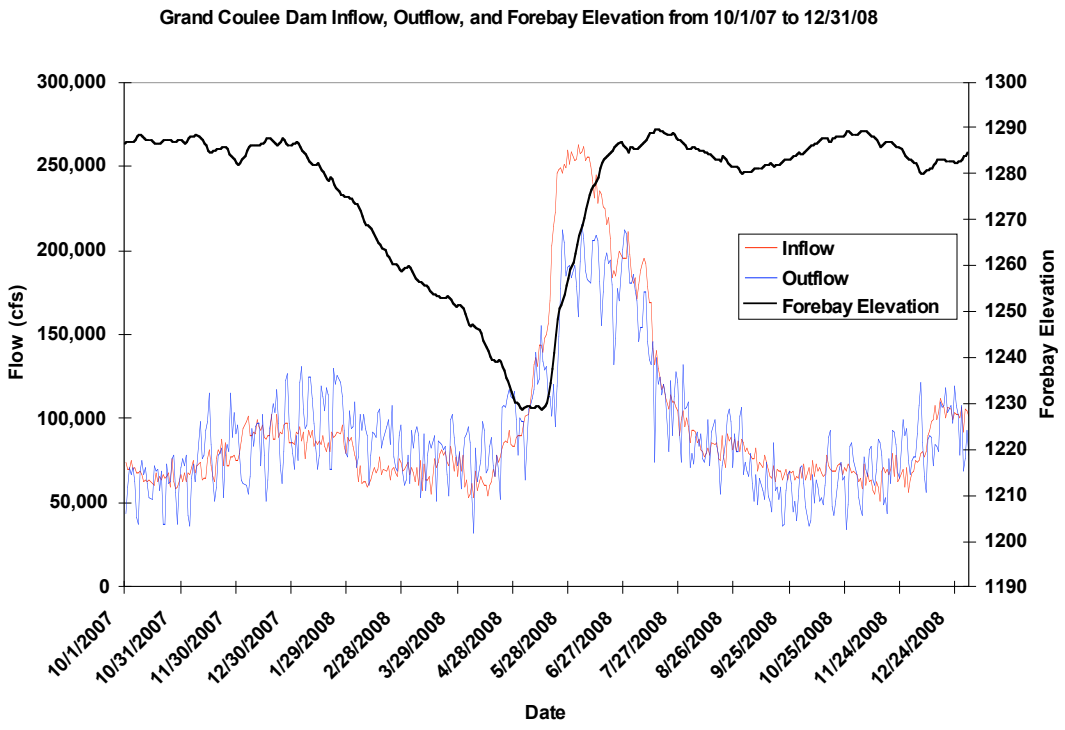

Figure 3. Grand Coulee Dam Inflow, Outflow, and Forebay Elevation from October 1, 2007, through December 31, 2008.

From October to December 2008, Libby was regulated to meet the projected end-of-December target, to optimize for power any draft to meet the December flood control target, and to limit any fluctuations by operating to the ramping rates in the 2006 U.S. Fish and Wildlife Service (USFWS) BiOp. The project followed the end-of-December variable flood control draft based on the December early season forecast. This forecast was 5,944 kaf for the April-to-August inflow volume forecast. This forecast set the end-of-December flood control target at 2,411 feet. Actual elevation on December 31 was 2,410.9 feet. Throughout 2008, Libby Dam avoided spill and did not violate the Montana state total dissolved gas standard of 110 percent. In accordance with the 2008 BiOp, Libby Dam also was regulated consistently with the Columbia River Treaty, the International Joint Commission, and the 1938 Order on Kootenay Lake.

Grand Coulee was operated during November and December of 2007 to help support chum spawning below Bonneville Dam and to help maintain the chum redd protection tailwater below Bonneville Dam of 11.5 feet through the winter of 2008. Also during this period, Grand Coulee was operated to help support the Vernita Bar protection flows of 50 kcfs. The project was operated using standard flood criteria, which included accepting a 147-kaf shift of flood control space from Dworshak on March 31 and a 500-kaf shift by April 15. Water supply forecasts for the basin above Grand Coulee during the April to September period were at 98 percent of average in January and 99 percent of average in June. To provide water for spring flows, Grand Coulee met the April 10 elevation objective of 1,244.5 feet and then drafted to 1,229.95 feet on April 30. In response to System Operations Request (SOR) 2008-2, Grand Coulee was drafted to provide flows to support McNary Dam flow objectives until the spring freshet began reaching minimum elevation of 1228.2 feet on May 3. Because of the flood

control draft, the Bureau of Reclamation was able to perform drum gate maintenance at Grand Coulee in 2008.

During the refill, there were periods of high flows and elevated TDG because of forced spill in the Columbia River. To minimize downstream spill and TDG production in the Columbia River, operations were coordinated through the TMT and in accordance with the 2008 Total Dissolved Gas Management Plan (Appendix 4 of the 2008 Water Management Plan). Grand Coulee refilled to elevation 1,290 feet on July 14, as coordinated through the TMT and then began drafting for summer flow augmentation. Grand Coulee hit its elevation target of 1,280 feet on August 31. Pumping was reduced to Banks Lake during August, and Banks Lake reached an elevation of 1,565.1 feet on August 31.

Hungry Horse Dam

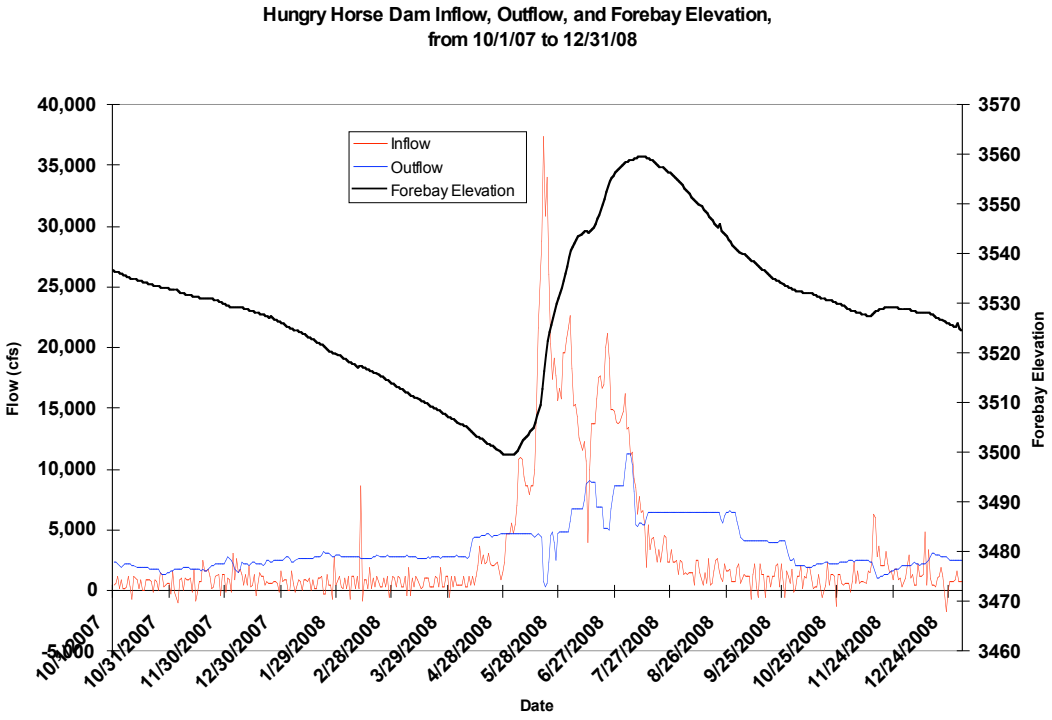

Figure 4. Hungry Horse Dam Inflow, Outflow and Forebay Elevation from October 1, 2007, through December 31, 2008.

Hungry Horse was operated through fall 2007 and throughout 2008 to maintain the minimum flow requirements of 3,500 cfs at Columbia Falls and 900 cfs in the South Fork Flathead River. Minimum flows were for ESA-listed bull trout and were calculated from a sliding scale based on the Hungry Horse inflow volume forecast. Hungry Horse operations in 2008 followed VARQ flood control procedures. The water supply forecast for Hungry Horse inflow from May to September was at 100 percent of average in January and increased to 116 percent of average by May. Hungry Horse was drafted to elevation 3,504.67 feet by April 10 for minimum flow requirements at Columbia Falls. The April 10 elevation target was 3,528.3 feet. Flows were increased to around 5 kcfs by April 11 to target refill and to shape the discharges into the spring migration period. Discharges were decreased twice in May for local flood protection on the mainstem of the Flathead River. During refill and throughout the 2008 water year, Hungry Horse was operated to avoid spill and to limit TDG production in the South Fork of the Flathead River to below Montana's standard of 110 percent. Hungry Horse also was

operated using the ramping rates as prescribed in the 2000 BiOp (FWS 2000). Hungry Horse refilled to elevation 3,559.04 feet on July 13 and then began drafting for summer flow augmentation.

Hungry Horse was operated to provide a stable flow operation during the summer flow augmentation period. The actual operation, which was coordinated through the Regional Forum, was a stable flow of 6.5 kcfs through August 31. Discharges were decreased temporarily August 23 to 24 to recover a drowning victim in the South Fork of the Flathead River below Hungry Horse Dam. Hungry Horse reached an elevation of 3541.02 feet on August 31.

Discharges ramped down from 6.5 kcfs to 4 kcfs between September 1 and 4 and were maintained at 4 kcfs until September 26. Flows were then ramped down to Columbia Falls minimum flow by October 1. The flat-flow operation through most of September, which is considered beneficial for resident fisheries, was coordinated with Montana.

Albeni Falls

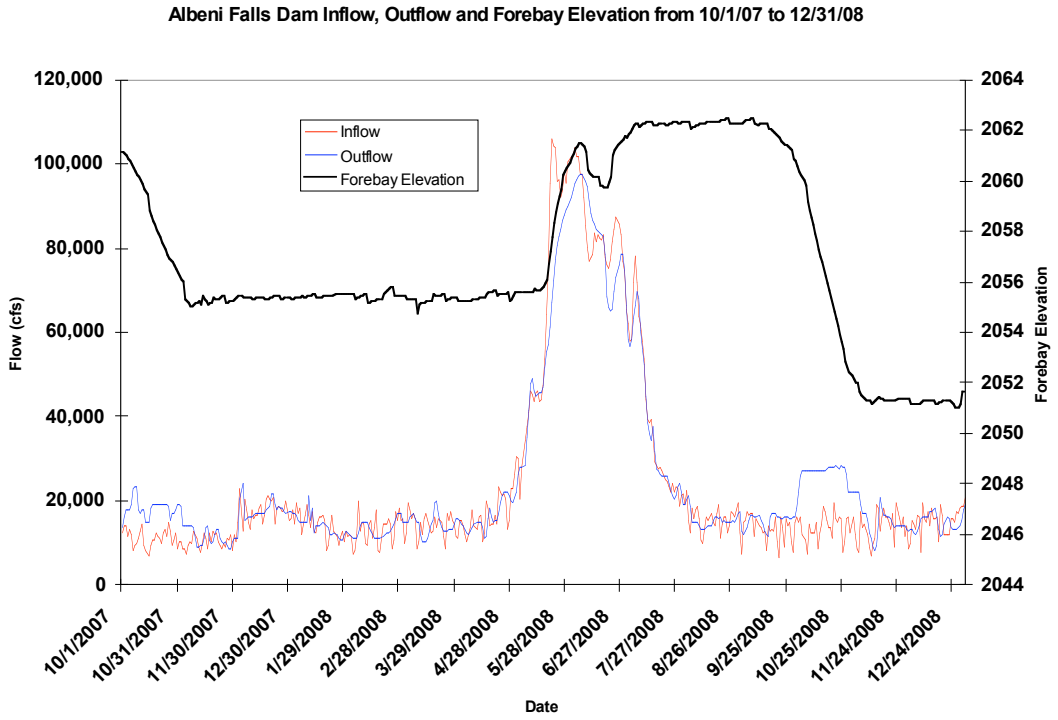

Figure 5. Albeni Falls Dam Inflow, Outflow and Forebay Elevation from October 1, 2007, through December 31, 2008.

The project was operated to standard flood control criteria. Lake Pend Oreille was drawn down to a minimum control elevation (MCE) of 2,055 feet for kokanee spawning in November 2007 after inter-agency coordination consistent with the USFWS' 2000 FCRPS BiOp (FWS 2000). The lake was operated between elevations 2055 and 2056 feet for kokanee incubation from January through April in 2008. Refill of Lake Pend Oreille started May 1, and the lake reached its target elevation 2062.25 feet in early July. For the remainder of the summer and through September, the lake elevation was maintained at between 2,062 and 2,062.5 feet. The lake was drawn down from October through November to reach an MCE of 2,051 feet, as determined through interagency coordination for kokanee spawning. The lake elevation was then held through December at between 2,051 and 2,051.5 feet

until the Idaho Department of Fish and Game declared the end of kokanee spawning on December 24. After the end of spawning was declared, the lake was managed to between 2,051 and 2,052 feet.

RPA Action 5 – Lower Columbia and Snake River Operations*: The Action Agencies will operate the FCRPS run-of-river mainstem lower Columbia River and Snake River projects (Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose and Lower Granite projects) to minimize water travel time through the lower Columbia and Snake rivers to aid in juvenile fish passage. These run-of-river operations will be included in the annual WMP (see RPA Action 6).*

The 2008 WMP included operations for these run-of-river projects. The projects were operated consistent with the WMP to minimize water travel time through the lower Columbia and Snake rivers to aid in juvenile fish passage and water temperature management. River operators do as much as possible to manage flows to help fish, while also managing for flood risk. Specific operating rules, including earmarking amounts of water for fish flows, are used at individual reservoirs to provide salmon flows, protect resident fish, control floods, and operate for other authorized purposes. Further discussions of these operations are included in the minutes of the TMT meeting "Annual Review of Lessons Learned 2008" at *http://www.nwd-wc.usace.army.mil/tmt/agendas/2008/1121min.pdf*

Lower Monumental and Ice Harbor projects operated from minimum operating pool (MOP) to MOP + 1 foot from April 3 through September 10. Before and after those dates, the projects operated in their full operating ranges. Lower Granite project operated from MOP to MOP + 1 foot from April 3 through September 10 and, after that, operated at elevation 734.5 to 738 feet to support broodstock collection. Little Goose project operated from MOP to MOP + 1 foot from April 3 through September 10 and, after that date, operated at elevation 633.5 to 638 feet, then 634 to 638 feet on September 12 for navigation safety. In a few instances, pool levels exceeded MOP criteria at Little Goose. This was due to the need to provide safe navigation conditions in the Little Goose pool, especially at the downstream sill of the Lower Granite navigation lock.

John Day Dam was operated at 262.5 to 264 feet from April 10 through September 30.

The storage projects in the Columbia and Snake rivers systems, which are describe under RPA 4 above, have limited ability to shape natural runoff. This limited storage capability can be managed to make modest adjustments in river flows for fish but cannot convert a dry water year into a much better one or save water from a wet year for future dry years. As a result, flow objectives for juvenile fish are goals that cannot be physically achieved under many conditions. The flow objectives were used for pre-season planning and in-season water management to guide decision making. Figures 6, 7, and 8 show the observed outflow at McNary, Lower Granite, and Priest Rapids relative to the flow objectives.

In 2008, the Columbia River had an average water year. During the spring, flows were low through mid-April and gradually increased through mid-May before increasing substantially in late May. Flows remained high from late May through mid-June before receding to low-flow conditions by mid-July. Flows remained low through the rest of the fish passage season.

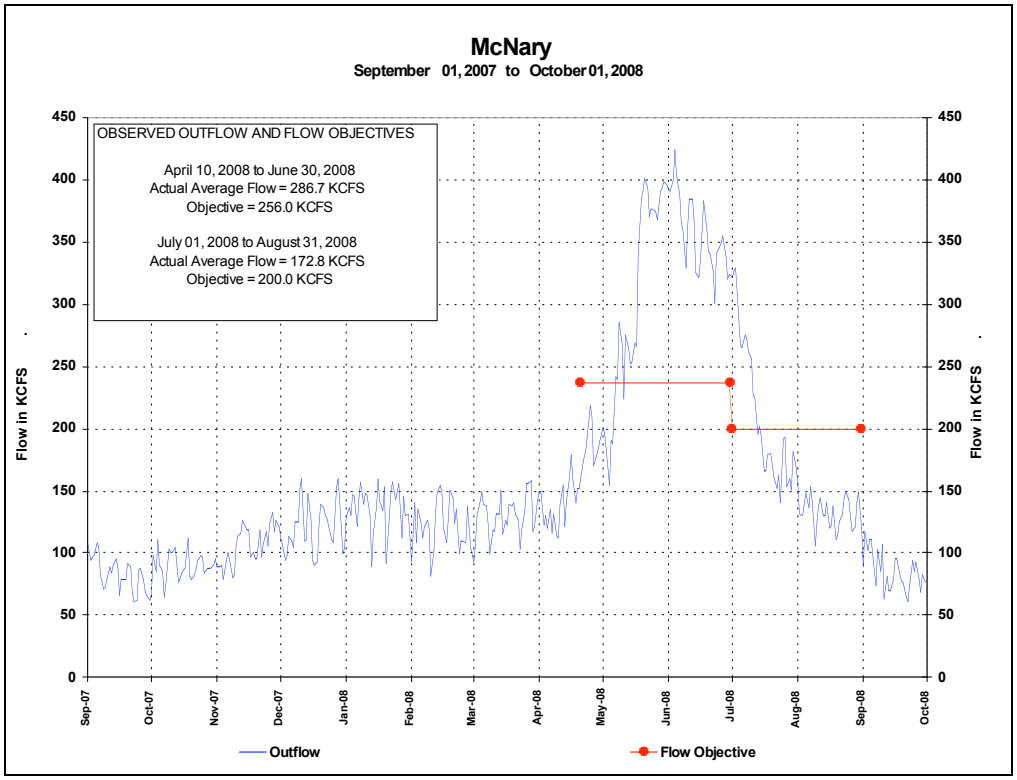

Figure 6. McNary Dam, Observed Outflow and Flow Objectives.
The flow objectives are not intended to be achieved in most water conditions; rather they are used for pre-season planning and in-season water management to guide decision making.

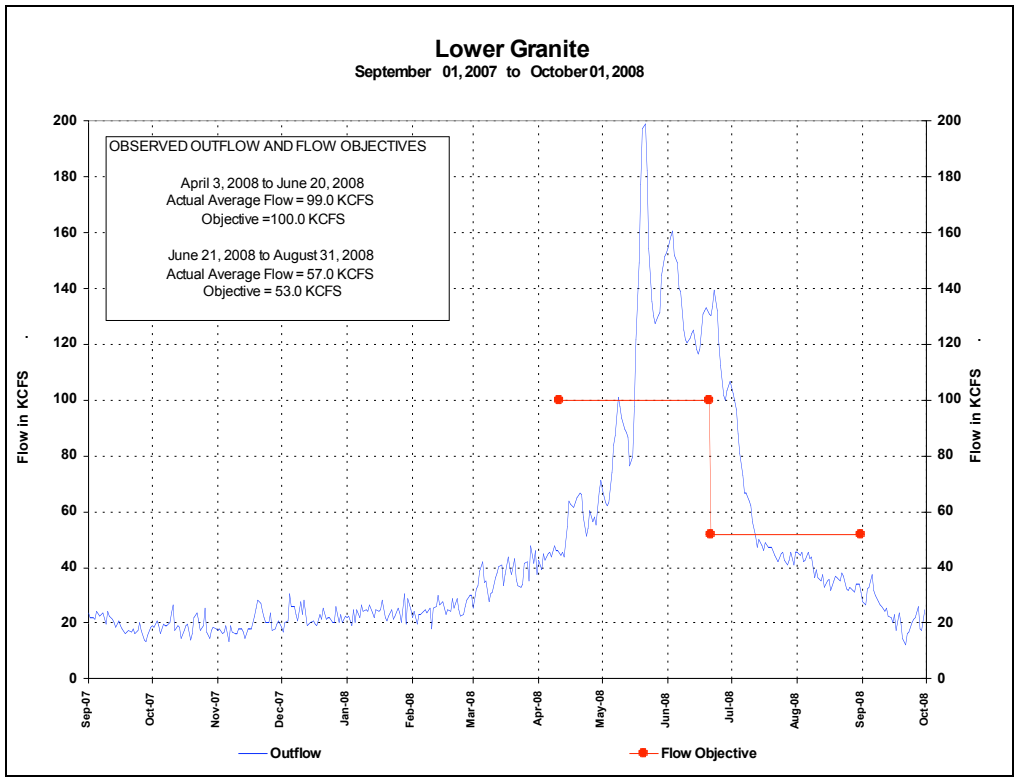

Figure 7. Lower Granite Dam, Observed Outflow and Flow Objectives.
The flow objectives are not intended to be achieved in most water conditions; rather they are used for pre-season planning and in-season water management to guide decision making.

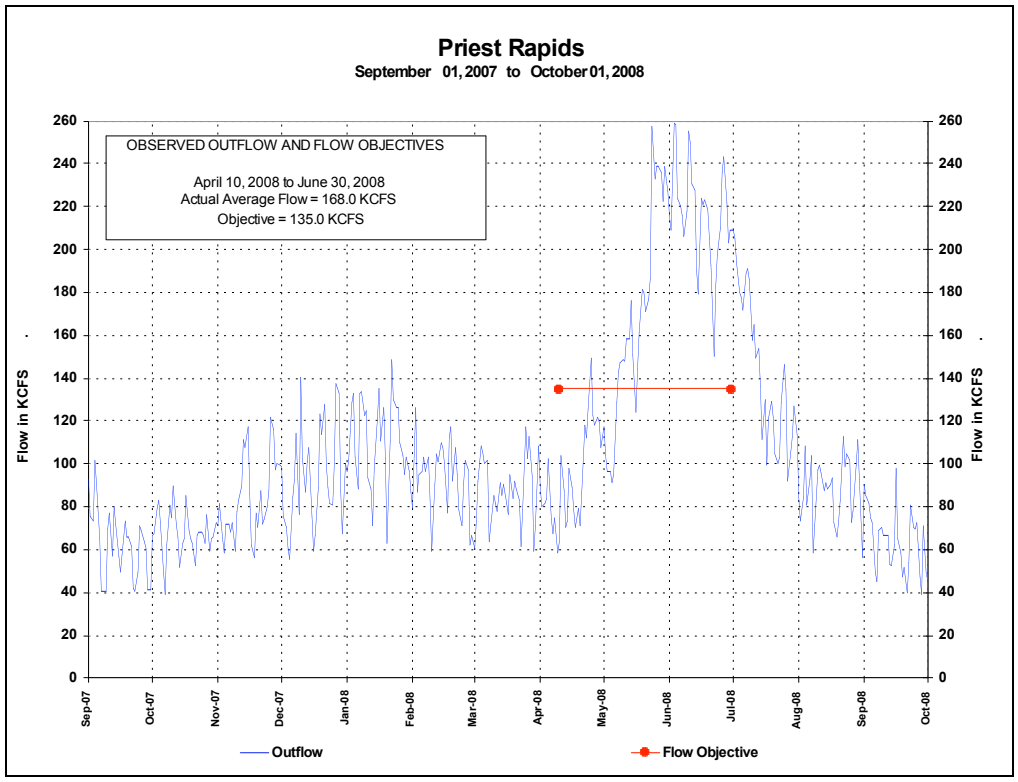

Figure 8. Priest Rapids Dam, Observed Outflow and Flow Objectives.
The flow objectives are not intended to be achieved in most water conditions; rather they are used for pre-season planning and in-season water management to guide decision making.

RPA Action 6 – In-Season Water Management*: Prioritization of the use of flow augmentation water is done through in-season management by the Regional Forum. Each fall, the Action Agencies will prepare an annual Water Management Plan (WMP) and seasonal updates that describe planned hydrosystem fish operations for the upcoming fall and winter, and for the spring, and summer passage seasons. The annual WMP strives to achieve the best possible mainstem passage conditions, recognizing the priorities established in the FCRPS BA and the need to balance the limited water and storage resources available in the region. Fall/winter and spring/summer updates are prepared as more data is available on the water conditions for that year. A draft update of the WMP will be prepared by October 1 each year, with a final plan completed by January 1. The fall/winter update to the WMP will be drafted by November 1 and finalized by January 1. A draft of the spring/summer update to the WMP will be prepared by March 1 and finalized by May 15.*

The annual Water Management Plan for the 2008 operating season (October 1, 2007, through September 30, 2008) was developed collaboratively with the region prior to the issuance of the 2008 FCRPS BiOp. The 2008 FCRPS BiOp was issued in May 2008; however, as described above, the court ordered a continuation of 2007 operations. Therefore, there were differences between the 2008 WMP and the 2008 BiOp.

The WMP for the 2009 operating season (October 1, 2008, through September 30, 2009) was prepared in accordance with the 2008 BiOp requirements. A draft was released on October 1, 2008; the fall/winter update was released on November 20. The final WMP was released on December 31 (Action Agencies 2008b), and the final fall/winter update was released on May 15, 2009.

RPA Action 7 – Forecasting and Climate Change/Variability*: The Action Agencies will hold annual forecast performance reviews looking at in-place tools for seasonal volume forecasts and to report on the effectiveness of experimental or developing/emerging technologies and procedures. As new procedures and techniques become available and are identified to have significant potential to reduce forecast error and improve the reliability of a forecast, the Action Agencies will discuss the implementation possibilities with regional interests. The purpose is to improve upon achieving upper rule curve elevations by reducing forecasts errors and thereby providing for improved spring flows. The Action Agencies will work collaboratively with other agencies and research institutions to investigate the impacts of*

possible climate change scenarios to the Pacific Northwest and listed salmon and steelhead. Focus areas will cover 1) modeling the hydrology and operations of the Columbia River system using possible future climate change scenarios, 2) investigating possible adaptation strategies for the system, 3) monitoring the hydrologic system for trends, cycles, and changes, and 4) staying abreast of research and studies that address climate cycles, trends, and modeling.

The Action Agencies and Fish Accord partners formed the Columbia River Forecast Group (CRFG), whose purpose is to promote and support the advancement of forecasting skill, products, and techniques in the Columbia River basin to improve reservoir operations for the benefit of the region. The group will provide an avenue for sharing, discussing, evaluating, and potentially implementing new forecasting techniques for the planning and operation of the FCRPS. The group's purview includes water supply, operational streamflow, and weather forecasting as it pertains to improving water supply and operational streamflow forecasting, hydrometeorological data quality and availability, and climate change. A key responsibility of the group will be to conduct an annual forecast performance workshop, slated for the fall of each year, to evaluate the performance of current and potential forecast techniques.

The CRFG began forming late in the year and met for the first time with only a core group in December 2008. The initial meeting focused on developing a charter and organizational structure, including a potential participant list. Because it was not possible to hold a fall 2008 workshop, the group decided that an interim workshop would be held in March 2009, with the intent to hold the full forecast performance workshop in either late October or early November 2009.

Recognizing the importance of assessing climate change impacts in reservoir models and water quality modeling, the Action Agencies provided funding and collaborative support to the Washington Department of Ecology (WDOE) to contract with the University of Washington's Climate Impacts Group (CIG) to develop climate change streamflow scenarios for the Columbia River basin. Understanding the development and appropriate application of these scenarios to regional modeling will aid in assessing the range and uncertainty associated with climate modeling and the potential impacts to the region's FCRPS BiOp recovery efforts. The scenarios defined under the WDOE contract were delivered in September 2009, and additional scenarios will be completed in the fall of 2009. All scenarios are being reviewed to ensure that they reflect scientifically sound methodologies for downscaling and bias correcting. The scenarios are a subset of the latest climate change models and emission scenarios produced under the Intergovernmental Panel on Climate Change (4th report).

RPA Action 8 – Operational Emergencies*: The Action Agencies will manage interruptions or adjustments in water management actions, which may occur due to unforeseen power system, flood control, navigation, dam safety, or other emergencies. Such emergency actions will be viewed by the Action Agencies as a last resort and will not be used in place of operations outlined in the annual WMP. Emergency operations will be managed in accordance with TMT Emergency Protocols, the Fish Passage Plan (FPP) and other appropriate Action Agencies emergency procedures. The Action Agencies will take all reasonable steps to limit the duration of any emergency impacting fish.*

No operational emergencies occurred in 2008.

RPA Action 9 – Fish Emergencies*: The Action Agencies will manage operations for fish passage and protection at FCRPS facilities. They may be modified for brief periods of time due to unexpected equipment failures or other conditions. These events can result in short periods when projects are operating outside normal specifications due to unexpected or emergency events. Where there are significant biological effects of more than short duration resulting from emergencies impacting fish, the Action Agencies will develop (in coordination with the in-season management Regional Forum and implement appropriate adaptive management actions to address the situation. The Action Agencies will take all reasonable steps to limit the duration of any fish to limit emergency.*

Two "fish emergency" situations occurred during 2008, one at Bonneville Dam and one at Little Goose Dam:

Bonneville Guidance Screen Removal. Starting May 16, 2008, high juvenile fish descaling was observed at the Bonneville Second Powerhouse (PH2) smolt monitoring facility. Upon inspection of the

juvenile bypass system, the project staff discovered a heavy accumulation of small sticks, leaves, and other detritus on vertical barrier screens (VBSs) in the system. The screens are designed to guide migrating juvenile fish to the juvenile bypass system (JBS). Coinciding with these events was an increase in total river flows to above 300 kcfs and unusually high river debris levels. Sensors that normally would have alerted project operators to this problem were out of calibration. Additionally, project personnel were not able to keep up with screen cleaning because the turbine intake extension (TIE) crane— a critical component for cleaning screens—was out of service. While project personnel focused efforts on cleaning the VBSs, excessive debris was accumulating on other system components, such as adult ladder water supply intakes. Regional coordination occurred with the TMT on May 21. Subsequently, the U.S. Army Corps of Engineers, with support from all TMT members, elected to remove the JBS intake screens (submersible traveling screens, or STSs). With this operational adjustment, fish that would otherwise pass through the JBS pass instead through turbines. This action circumvented a potential VBS failure, eliminated fish exposure to plugged screens, allowed PH2 to operate at full capacity (thereby minimizing spill-generated total dissolved gas), and allowed project personnel to maintain other critical fish passage system components. A modeling analysis of removing the STSs under the current conditions suggested that the effect on overall survival would be negligible (< 0.1 percent change). On May 27, Operations Division and the Bonneville Project assessed river flows and debris and determined that the conditions were not suitable to reinstall the STSs. The decision on when to reinstall screens was coordinated through the TMT regional forum. All screens were installed in accordance with the Fish Passage Plan (FPP, at *http://www.nwd-wc.usace.army.mil/tmt/documents/fpp*)) by June 18 and remained in place for the rest of the fish passage season.

Little Goose Dam: At Little Goose Dam, in late August when river flows were very low, spill was changed from 30 percent to 11 kcfs.

In both instances, these actions were coordinated with the region through the TMT process.

RPA Action 10 – Describe actions taken to provide 1 MAF of treaty storage*: BPA and the Corps will pursue negotiations with Canada of annual agreements to provide 1 MAF of storage in Treaty space by April 15 consistent with:*

- *Providing the greatest flexibility possible for releasing water to benefit U.S. fisheries May through July.*
- *Giving preference to meeting April 10 upper rule curve elevation or achieving refill at Grand Coulee Dam over flow augmentation storage in Canada in lower water supply conditions.*
- *Releasing flow augmentation storage to avoid causing damaging flow or excessive TDG in the United States or Canada.*
- *BPA and the Corps will coordinate with Federal agencies, States and Tribes on Treaty operating plans.*

The Columbia River Treaty Operating Committee Agreement on Operation of Treaty Storage for Non-Power Uses for December 15, 2007, through July 31, 2008, was executed December 12, 2007. Under this agreement, 1 MAF of flow augmentation water was stored in Mica Reservoir during January 2008. All flow augmentation storage was released by June 30, 2008, under the Non-Power Uses Agreement. The Non-Power Uses Agreement for December 15, 2008, through July 31, 2009, was executed November 20, 2008.

RPA Action 11 – Non-Treaty Storage*: BPA, in concert with BC Hydro, will refill the remaining non-Treaty storage space by June 30, 2011, as required under the 1990 non-Treaty storage agreement. Refill will be accomplished with minimal adverse impact to fisheries operations.*

Conditions were such that no Non-Treaty Storage was returned during the 2008 operating year (September 2007 - August 2008). However, because September 2008 falls within the period of this 2008 BiOp Progress Report, it should be noted that 52 thousand second-feet per day (ksfd) was stored into Non-Treaty storage and brought the U.S. account to 73 percent of full on September 30, 2008.

RPA Action 12 – Non-Treaty Long-Term Agreement*: BPA will seek to negotiate a new long-term agreement on use of non-Treaty space in Canada so long as such an agreement provides both power and non-power benefits for BC Hydro, BPA, and Canadian and U.S. interests. As part of these negotiations, BPA will seek opportunities to provide benefits to ESA-listed fish, consistent with the Treaty. If a new long-term, non-Treaty agreement is not in place, or does not address flows for fisheries purposes, BPA will approach BC Hydro about possibly negotiating an annual/seasonal agreement to provide U.S. fisheries benefits, consistent with the Treaty.*

Before approaching BC Hydro to negotiate a new long-term, non-treaty storage agreement, BPA has committed to the following:

- Substantial refilling the U.S. non-treaty storage account
- The Dry Year Strategy Work Group defining potential use of non-treaty storage in dry years
- Coordinating with federal agencies, states, and tribes under the BiOp
- Coordinating with tribes under the Fish Accords
- Establishing the collective U.S. interests in terms of such a new non-treaty storage (NTS) agreement

In addition, BC Hydro has agreed to coordinate with Canadian stakeholders on reservoir impacts in Canada. Stakeholder coordination in Canada and the United States could begin as early as fall 2009.

RPA Action 13 – Non-Treaty Coordination with Federal Agencies, States, and Tribes*: Prior to negotiations of new long-term or annual non-Treaty storage agreements, BPA will coordinate with Federal agencies, States, and Tribes to obtain ideas and information on possible points of negotiation, and will report on major developments during negotiations.*

No long-term or annual non-treaty storage agreements were negotiated.

RPA Action 14 – Dry Water Year Operations*: Flow management during dry years is often critical to maintaining and improving habitat conditions for ESA-listed species. A dry water year is defined as the lowest 20th percentile years based on the Northwest River Forecast Center's (NWRFC) averages for their statistical period of record (currently 1971 to 2000) using the May final water supply forecast for the April to August period as measured at The Dalles. The Action Agencies will complete the following activities to further the continuing efforts to address the dry flow years:*

- *Within the defined "buckets" of available water (reservoir draft limits identified in RPA Action 4), flexibility will be exercised in a dry water year to distribute available water across the expected migration season to optimize biological benefits and anadromous fish survival. The Action Agencies will coordinate use of this flexibility in the Regional Forum TMT.*
- *In dry water years, operating plans developed under the Treaty may result in Treaty reservoirs being operated below their normal refill levels in the late spring and summer, therefore, increasing flows during that period relative to a standard refill operation.*
- *Annual agreements between the U.S. and Canadian entities to provide flow augmentation storage in Canada for U.S. fisheries needs will include provisions that allow flexibility for the release of any stored water to provide U.S. fisheries benefits in dry water years, to the extent possible.*
- *BPA will explore opportunities in future long-term NTS storage agreements to develop mutually beneficial in-season agreements with BC Hydro to shape water releases using NTS space within the year and between years to improve flows in the lowest 20th percentile water years to the benefit of ESA-listed ESUs, considering their status.*
- *Upon issuance of the FCRPS Biological Opinion, the Action Agencies will convene a technical workgroup to scope and initiate investigations of*
- *Alternative dry water year flow strategies to enhance flows in dry years for the benefit of ESA–listed ESUs.*
- *In very dry years, the Action Agencies will maximize transport for Snake River migrants in early spring, and will continue transport through May 31.*
- *BPA will implement, as appropriate, its Guide to Tools and Principles for a Dry Year Strategy to reduce the effect energy requirements may pose to fish.*

Because the 2008 water year did not meet the definition for a dry year, the dry year strategy was not implemented.

The Dry Year Strategy Work Group was to convene upon completion of the BiOp. The Action Agencies convened a Dry Year Strategy technical work group, which held its first meeting on July 17, 2008. Participants included Action Agencies, NOAA Fisheries, and representatives from the Colville and

Spokane tribes and Montana. Most of the discussion involved previous analyses of dry year operations and the need to evaluate biological effects. Numerous handouts were shared to refresh the participants' memories of the previous analyses conducted during the BiOp remand collaboration. Also, a biological team was formed to further discuss analytical methods for assessing biological effects.

The Dry Year Strategy Work Group met again on August 11, 2008. Additional participants at the second meeting included representatives from Oregon and the Northwest Power and Conservation Council (NPCC). Again, most of the discussion centered on previous analyses. Additionally, the group discussed and agreed to take more time to complete this work than was proposed in the Biological Assessment (BA) to allow participation by key stakeholders.

RPA Action 15 – Water Quality Plan for Total Dissolved Gas and Water Temperature in the Mainstem Columbia and Snake Rivers*: The Action Agencies will continue to update the Water Quality Plan for Total Dissolved Gas and Water Temperature in the Mainstem Columbia and Snake Rivers (WQP) and implement water quality measures to enhance ESA-listed juvenile and adult fish survival and mainstem spawning and rearing habitat.*

The Water Quality Plan for Total Dissolved Gas and Water Temperature in the Mainstem Columbia and Snake Rivers (ACOE 2009) was updated in January 2009. The 2009 plan was a collaborative effort among the Corps and regional federal, state, local, and tribal stakeholders and was tied into other past and current water quality efforts in the region. This document sets forth the Corps' plan to improve water quality in the mainstem Columbia and Snake rivers with respect to the following:

- Actions in the 2008 BiOp that pertain to improving water quality for ESA- listed salmon and steelhead
- Applicable total maximum daily loads (TMDLs) (Currently there are three TMDLs for TDG in the lower Columbia River, lower Snake River, and middle Columbia River, which are in effect until 2020.)
- Other actions to move toward attainment of U.S. Environmental Protection Agency (EPA) promulgated or approved state and tribal water quality standards in the Columbia and Snake rivers

In 2008 the Action Agencies implemented the water quality measures required by the previous (November 2006) Water Quality Plan.

Real-time monitoring and reporting of TDG and temperatures measured at fixed monitoring sites:

TDG and temperature were monitored and reported in 2008 according to the *Corps of Engineers Plan of Action for Dissolved Gas Monitoring in 2008* (ACOE 2008a). Access to the data is available by clicking on various links at *http://www.nwd-wc.usace.army.mil/tmt/* .

Continued development of fish passage strategies with less production of TDG:

In 2008 three planning studies analyzed opportunities to continue development of fish passage strategies and reduce TDG through structural and operational alternatives:

- Ice Harbor Dam: A study evaluated 12 structural and operational scenarios to meet fish passage and reduce TDG for the Ice Harbor Dam Configuration and Operation Plan. Results indicated that lower TDG loadings can be realized through optimizing spill volume and pattern with removable spillway weir (RSW) flows.
- John Day Dam: A decisional analysis framework was used to evaluate passage improvement alternatives. Evaluation factors included juvenile fish survival, effects on other species and life stages, costs, economic impacts, TDG, implementation timing, and data uncertainty. The

SYSTDG model was used to provide a relative comparison of TDG characteristics for the different alternatives. The results identified cost-effective surface flow routes such as the top spillway weir, tailrace improvement, and behavioral guidance through the spillway.

- The Dalles Dam: A study evaluated two spillwall locations to improve egress conditions for fish passage. The preferred alternative (which is currently under construction) was selected based on TDG minimization.

Finally, the Corps' Portland and Walla Walla districts have continued to evaluate structural and operational alternatives that will satisfy objectives in the Endangered Species Act and Clean Water Act. Additionally, estimates have been developed describing the TDG exchange properties in the Snake River at Lower Granite Dam as a function of alternative structural configurations, operational policies, total river flow rate, and background TDG properties. These estimates are in a draft form and are expected to be finalized in 2009.

Update the SYSTDG model to reflect modifications to spillways or spill operations:

The SYSTDG model was used as a decision support tool to manage spill at lower Columbia and Snake River projects. As part of this use, the model was modified to account for structural and operational changes to the projects.

Continued development and use of SYSTDG model for estimating TDG production to assist in real-time decision making, including improved wind forecasting capabilities as appropriate:

After the completion of the fish migration season, a statistical evaluation of the predictive errors was performed on observed TDG levels during the 2008 fish passage season to quantify the uncertainty of SYSTDG estimates and improve modeling accuracy and reliability. The results of this analysis are included as Appendix G of the *2008 Dissolved Gas and Water Temperature Monitoring Report* at *http://www.nwd-c.usace.army.mil/tmt/wq/tdg_and_temp/2008/*. Wind forecasting capabilities must await the acquisition of more comprehensive, representative, and reliable wind data, which are now being developed.

Continued development of the CEQUAL-W2 model for estimating river temperatures from Dworshak Dam on the Clearwater and Upper Snake River near the confluence with the Grand Ronde River (USGS Anatone gauge) through the lower Snake River (all four Corps lower Snake River projects) to assist in real-time decision making for Dworshak Dam operations:

The CEQUAL-W2 model was used in 2008 from late June through mid-August to support decisions regarding operation of Dworshak Dam for flow augmentation and temperature management on the lower Snake River. The model was run numerous times, and the results were presented to TMT on July 16, July 30, August 6, and August 13. Notes from these meetings can be found at *http://www.nwd-wc.usace.army.mil/tmt/agendas/2008/* . No modifications were made to the model in 2008 for developmental improvements or re-calibrations.

Expand water temperature modeling capabilities to include Columbia River from Grande Coulee to Bonneville dams to better assess the effect of operations or flow depletions on summer temperatures:

In 2008 this issue was addressed in the context of TMDL discussions with EPA. Supporting studies are scheduled to begin in January 2010.

Investigate alternatives to reduce total mass loading of TDG at Bonneville Dam while maintaining juvenile survival performance:

In 2008, as part of the COP update, a study was initiated to evaluate potential spillway improvements in conjunction with a planned rehab program. The study is looking at potential

spillway passage efficiency and survival improvements as well as opportunities to reduce spill and TDG levels below the project without compromising these passage parameters.

Continued operation of the Lower Snake River projects at MOP:

All of the lower Snake River projects were operated at minimum operating pool (MOP) for the 2008 fish migration season. See additional information under RPA 5.

RPA Action 16 – Tributary Projects*: The tributary projects that have not yet completed ESA Section 7 consultation are located in the Yakima, Okanogan, and Tualatin river basins. Reclamation will, as appropriate, work with NOAA Fisheries in a timely manner to complete supplemental, project-specific consultations for these tributary projects. These supplemental consultations will address effects on tributary habitat and tributary water quality, as well as direct effects on salmon survival in the tributaries. The supplemental consultations will address effects on mainstem flows only to the extent to which they reveal additional effects on the in-stream flow regime not considered in the FCRPS and Upper Snake River BA/Comprehensive Analysis.*

Reclamation is working on ESA Section 7 consultations for the Yakima, Okanagan, and Tualatin Project operations.

Consultation on Reclamation's Yakima Project continued during 2008. [For 2009, Reclamation is working on a supplement to the 2000 Biological Assessment "Yakima Project Operations and Maintenance, Supplemental to the 1999 Biological Assessment on the FCRPS."]

In May 2008, NOAA Fisheries indicated that it was going to delay work on the BiOp for the Okanogan Project for 6 months while information was collected that might result in modification of the proposed action. The Fish Accords included funds to acquire an additional 500 acre-feet of supplementation water. The provision of this water was included as part of the proposed action in the Okanogan Project BA, which was submitted to NOAA Fisheries in November 2008.

In March 2008, Reclamation submitted to NOAA Fisheries the final Biological Assessment for Bureau of Reclamation Future Operations and Maintenance in the Tualatin River Subbasin, Tualatin Project. NOAA Fisheries has accepted this BA for consultation purposes and a BiOp is under development.

RPA Action 17 – Chum Spawning Flows*: Provide adequate conditions for chum spawning in the mainstem Columbia River in the area of the Ives Island complex and/or access to the Hamilton and Hardy Creeks for this spawning population.*

For chum tailwater readings, the official gauge is 0.9 mile downstream from Bonneville Dam's first powerhouse, 50 feet upstream from Tanner Creek and at River Mile ®M 144.5.

Chum operations were coordinated regularly via TMT from before chum spawning began through the end of chum emergence. Beginning on the evening of November 9, 2007, Bonneville was operated at a tailwater elevation of between 11.3 and 11.7 feet. High inflows from the end of November through December necessitated deviations to move excess water at night (1900-0700) when chum tend not to spawn.

On the morning of December 24, 2007, when operations shifted from a spawning to an incubation operation, a 24-hour minimum tailwater elevation of 11.5 feet took effect to protect chum redds through incubation and the end of emergence. From March 6 through March 10, spill was provided at Bonneville Dam for the Spring Creek Hatchery release. During this period through 0500 on March 10 a minimum tailwater was maintained between 12.5 and 13 feet to provide depth compensation and protect chum redds from TDG produced by the spill operation. Salmon managers advised the action agencies that chum emergence had ended by April 9 and so there was no need to delay the start of spring spill for juvenile passage or provide depth compensation to keep TDG levels below 105 percent in the vicinity of the redds. The project operated to 11.5-foot tailwater as a soft constraint to facilitate chum fry egress following emergence. This soft constraint was removed on April 11.

Beginning November 7, 2008, Bonneville was operated at a tailwater elevation of between 11.3 and 11.7 feet with excess water shaped into evening hours during chum spawning to the extent possible. Chum operations were complicated by forebay constraints in place to facilitate construction of the spillwall at the Dalles Dam. As a result, the TMT developed contingency plans for managing chum operations that established a priority for actions to be taken to manage excess water if it could not be managed at night.

RPA Action 18 – Configuration and Operation Plan for Bonneville Project*: The Corps will consider all relevant biological criteria and prepare, in cooperation with NOAA Fisheries and the co-managing agencies, a Configuration and Operational Plan for the Bonneville Project (2008). As part of the first phase of modifications, the Corps will investigate, and implement the following reasonable and effective measures to reduce passage delay and increase survival of fish passing through the forebay, dam, and tailrace as warranted. Initial modifications will likely include:*

- *Bonneville Powerhouse I*
- *Sluiceway modifications to optimize surface flow outlet to improve fish passage efficiency (FPE) and reduce forebay delay (2009).*
- *Minimum-gap turbine runner installation to improve survival of fish passing through turbines (2009)*
- *Bonneville Powerhouse II*
- *Screened bypass system modification to improve fish guidance efficiency (FGE) and reduce gatewell residence time (2008)*
- *Shallow BGS installation to increase Corner Collector efficiency and reduce forebay delay (prototype 2008)*
- *Bonneville Dam Spillway*
- *Spillway operation or structure (e.g., spillway deflectors) modification to reduce injury and improve survival of spillway passed fish; and to improve conditions for upstream migrants (2013).*

  The COP will be updated periodically and modifications may be made as new biological and engineering information is gathered. The COP and modifications will be coordinated through the Regional Forum. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. If Phase I actions fail to meet the intended biological targets, the COP will be updated to identify additional Phase II actions for further implementation.

In 2008, the Bonneville Configuration and Operation Plan was updated to document planned additional configuration actions with the intent to bring juvenile passage survival to levels meeting BiOp performance targets. Actions in 2008 in the COP are as follows:

- An initial contract was awarded in late 2008 for the first phase of modifications to the B1 sluiceway to improve its performance as a surface passage route. The work, which is scheduled for completion in 2009, replaced three chain gates with automated sluice gates that will change position as the forebay water elevation changes. This will improve entrance conditions and provide better flow conditions in the sluiceway. An additional modification to remove the existing sluiceway divider wall is currently scheduled to be completed by 2010.
- The construction contract for rehab of the B1 turbines and generators, including installation of minimum gap runners, continued through 2008, with completion of Unit 8. Completion of the final two units is scheduled for 2009.
- The multi-year contract to modify the 2nd powerhouse screened bypass system to improve fish guidance efficiency was completed in 2008. Follow-on work was done to investigate potential problems with some observed injuries and mortalities in the gate wells.
- A shallow draft behavioral guidance screen (BGS) was installed and tested in the 2nd powerhouse forebay. The purpose was to test the shallow draft BGS to determine whether it

could provide increased guidance of juvenile migrants in the forebay into the corner collector to take advantage of high survival rates for fish passing through that route. In 2008, 47 percent of the yearling Chinook that passed Powerhouse 2 went through the corner collector, compared to 44 percent in previous years. The percentage of subyearling Chinook and steelhead that passed through the corner collector was similar to previous years: 40 percent and 71 percent, respectively. A second year of testing is planned for 2009.

- A study was initiated to evaluate potential spillway improvements in conjunction with a planned rehab program. The study is looking at potential spillway passage efficiency and survival improvements as well as opportunities to reduce spill and TDG levels below the project without compromising these passage parameters. See also RPA Action 15.
- An evaluation of new spillway spill patterns and discharges was conducted in 2008 to determine whether operational changes would improve juvenile fish survival. In the spring, relative survival of yearling Chinook passing through the spillway under a 100-kcfs, 24-hour-per-day spill operation was evaluated. Relative survival was estimated at 100 percent, which is a substantial improvement compared to the 92 percent relative survival measured under the 75-kcfs day/120 percent TDG cap night operation in 2004–2005. In the summer, subyearling Chinook survival through the spillway was estimated under a 85-kcfs day/120 percent TDG cap night spill operation. Relative survival was estimated at 97 percent, a substantial increase over the 89 percent measured under the 75-kcfs day/120 percent TDG cap night operation in 2004–2005.

RPA Action 19 – Configuration and Operation Plan for The Dalles Project*: The Corps will consider all relevant biological criteria and prepare, in cooperation with NOAA Fisheries and the co-managing agencies, a Configuration and Operational Plan for The Dalles Project (2008). As part of the first phase of modifications, the Corps will investigate, and implement the following reasonable and effective measures to reduce passage delay and increase survival of fish passing through the forebay, dam, and tailrace as warranted. Initial modifications will likely include:*

- *Turbine operation optimization to improve overall dam survival (2011)*
- *Extended tailrace spill wall to increase direct and indirect survival of spillway passed fish (2010)*
- *The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. The COP and modifications will be coordinated through the Regional Forum. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. If Phase I actions fail to meet the intended biological targets, Phase II actions will be considered for further implementation.*

In 2008, an update of The Dalles COP was initiated to document planned additional configuration actions with the intent to bring juvenile passage survival to levels meeting BiOp performance targets. (The update was completed in 2009). The 2008 COP actions are as follows:

- A two-year construction contract was awarded to initiate construction of an extended (700-foot) spillwall between Spillway Bays 8 and 9. The contract is scheduled to be completed during 2009–2010 in the water work period. The purpose of the project is to improve juvenile passage egress and survival below the dam.

RPA Action 20 – Configuration and Operation Plan for John Day Project*: The Corps will consider all relevant biological criteria and prepare, in cooperation with NOAA Fisheries and the co-managing agencies, a Configuration and Operational Plan for the John Day Project (2008). As part of the first phase of modifications, the Corps will investigate, and implement the following reasonable and effective measures to reduce passage delay and increase survival of fish passing through the forebay, dam, and tailrace as warranted. Initial modifications will likely include:*

- *Full-flow bypass and PIT-tag detection installation to reduce handing stress of bypassed fish (2007)*
- *Turbine operation optimization to improve overall dam survival (2011)*

- *Surface flow outlet(s) construction to increase FPE, reduce forebay delay and improve direct and indirect survival (prototype 2008 with final installation by 2013), and improve tailrace egress conditions.*
- *The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. The COP and modifications will be coordinated through the Regional Forum. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. If Phase I actions fail to meet the intended biological targets, Phase II actions will be considered for further implementation.*

A COP for John Day was completed in 2007. The report laid out a two-phase plan to achieve performance standards. Phase 1 included continued evaluation of surface passage using top spill weirs to reduce turbine entrainment in conjunction with tailrace modifications for improved egress conditions. Following biological evaluations of Phase 1 modifications, Phase 2 alternatives may be necessary. An addendum to the 2007 COP will be prepared in 2009 to document the current plan to construct an extended deflector on Spillbay 20 to improve tailrace passage conditions. Actions in 2008 on measures being developed for the COP are summarized as follows:

Fabrication and installation of a prototype top-spill weir (TSW) for Spillbays 15 and 16 began in fiscal year 2007 and were completed for initial operation and testing in 2008. Two years of testing were planned. The purpose of the TSW test was to assess how effective surface spill is at reducing turbine entrainment, which would verify an assumption from the COP that surface spill will reduce turbine passage of juvenile salmon by 50 percent. In 2008, acoustic telemetry was used to evaluate yearling Chinook, steelhead, and subyearling Chinook passage distribution, behavior, and survival under the TSW configuration and operation.

For all species and age groups, fish passage efficiency (the proportion of fish passing non-turbine routes) and spill passage efficiency were higher than in previous years. Spill passage efficiency was 76 percent for yearling Chinook, 74 percent for steelhead, and 69 percent for subyearling Chinook. Turbine entrainment was reduced by 50 percent or more for all groups as well. Relative survival of yearling Chinook and steelhead passing the dam was 95.7 percent and 98.6 percent, respectively. Subyearling Chinook dam passage relative survival was 86.1 percent, which was lower than the 89 percent BiOp base condition. Numerous gulls were observed feeding in the John Day Dam tailrace during the summer study, and day/night survival differences suggest that subyearling Chinook mortality was related to the gull predation. A new avian wire array will be installed for 2009 to deter gull predation, and an avian predation component to the 2009 study will be added.

Evaluations of alternatives for tailrace modifications continued through 2008. This resulted in a tentative recommendation to construct an extended deflector at Spillbay 20.

RPA Action 21 – Configuration and Operational Plan (COP) for the McNary Project*: The Corps will consider all relevant biological criteria and prepare, in cooperation with NOAA Fisheries and the co-managing agencies, a Configuration and Operational Plan for the McNary Project (2009). As part of the first phase of modifications, the Corps will investigate, and implement the following reasonable and effective measures to reduce passage delay and increase survival of fish passing through the forebay, dam, and tailrace as warranted. Initial modifications will likely include:*

- *Turbine operation optimization to improve survival of fish passing through turbines (2013)*
- *Improve debris management to reduce injury of bypass and turbine passed fish (2011)*
- *Relocate juvenile bypass outfall to improve egress, direct, and indirect survival on bypassed fish (2011)*
- *Surface flow outlet installation to increase FPE, reduce forebay delay, and improve direct and indirect survival (temporary structure testing in 2007 and 2008 to develop a permanent system)*
- *The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. The COP and modifications will be coordinated through the Regional Forum. Comments developed by NOAA Fisheries on the draft*

COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. If Phase I actions fail to meet the intended biological targets, Phase II actions will be considered for further implementation.

Progress continued in 2008 on surface passage alternative feasibility studies and biological testing of prototype spillway weirs at McNary Dam. Information and data resulting from these actions will inform alternative evaluation and selection during preparation of the McNary COP in 2009. Significant accomplishments are as follows:

- **Juvenile Fish Surface Passage Feasibility Study** – A draft report evaluating the engineering feasibility, operational concerns, and magnitude of cost associated with various surface passage alternatives was completed in December 2008. Eleven alternatives taken to a concept level underwent an evaluation and selection process conducted with regional stakeholders. Four alternatives were carried forward for detailed evaluation of engineering feasibility and cost. The biological advantages and disadvantages of each of these alternatives will be more thoroughly evaluated during preparation of the COP, including tradeoff analyses. Alternatives will be prioritized using the COP tiered evaluation process developed with regional stakeholders in 2008.

- **Prototype Spillway Weir Evaluation** – In 2008, the second year of biological testing was conducted to assess relative juvenile survival, passage efficiencies, and forebay behavior while operating two prototype spillway weirs. In 2007, the weirs were installed in Spillbays 20 and 22. During 2008, the weir in Spillbay 22 was moved to Spillbay 19 to investigate whether this configuration would improve biological performance. Spill operations maintained for this test and biological performance are discussed below.

- **Evaluation of Survival and Passage Rates with Respect to Spill Operations** – In 2008, the primary objective was to gather information on approach behavior, passage route use, and survival after passage under changed spillway weir configuration. These data were collected to facilitate a decision on the most effective location for a permanent surface passage structure at McNary Dam.

  During the spring fish passage season, a single treatment test of 40 percent spill was evaluated. Passage over the spillway weirs decreased, particularly for steelhead, when the spillway weir was shifted from Spillbay 22 to Spillbay 19. Overall steelhead passage dropped from 65.7 percent over the spillway weirs in 2007 to 53.1 percent in 2008. Yearling Chinook passage over spillway weirs also was lower during 2008. The flow years differed in that 2008 had an average flow 40 kcfs higher than in 2007. Surface flow outlets generally have shown less efficient passage at higher flow levels. Steelhead dam passage relative survival of 99.9 percent exceeded the 2008 BiOp spring performance standard[2] during 2008, but for yearling Chinook, dam passage relative survival was 95.8 percent, which is just under the 96.0 percent spring migrant BiOp performance standard.

[2] The juvenile dam passage performance standards are an average across Snake River and Lower Columbia River dams of 96 percent dam passage survival for spring Chinook and steelhead and 93 percent average across all dams for Snake River subyearling Chinook, estimated to a precision level of +/- 3 percent at the 95 percent confidence interval precision using route specific relative survival estimating techniques. Dam passage survival is defined as survival from the upstream face of the dam to a standardized reference point in the tailrace. If the dam survival estimates exceed the standard in two separate years, the target would be met for that dam. Dam passage survival as defined in the BiOp is also called concrete survival in the research results.

During the summer passage season, a two-treatment test (40 percent versus 60 percent spill operation) was performed. At 60 percent spill, subyearling Chinook passage over the spillway weirs was notably lower during 2008 than in 2007. The average summer flow volume was also higher in 2008, similar to that observed in the spring. The summer migrant dam passage BiOp survival performance standard of 93.0 percent was exceeded during 60 percent spill operations for subyearling Chinook (95.9 percent) and was just missed during 40 percent spill operations (92.9 percent).

RPA Action 22 – Configuration and Operation Plan for the Ice Harbor Project*: The Corps will consider all relevant biological criteria and prepare, in cooperation with NOAA Fisheries and the co-managing agencies, a Configuration and Operational Plan for the Ice Harbor Project (2008). As part of the first phase of modifications, the Corps will investigate, and implement the following reasonable and effective measures to reduce passage delay and increase survival of fish passing through the forebay, dam, and tailrace as warranted. Initial modifications will likely include:*

- *Guidance screen modification to improve FGE (2010)*
- *Turbine operation optimization to improve survival of turbine passed fish (2011)*
- *Spillway chute and/or deflector modification to reduce injury and improve survival of spillway passed fish through the RSW (2009)*
- *Turbine unit 2 replacement to improve the survival of fish passing through turbines and reduce oil spill potential (2012)*

The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. The COP and modifications will be coordinated through the Regional Forum. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. If Phase I actions fail to meet the intended biological targets, Phase II actions will be considered for further implementation.

The Ice Harbor COP, initiated in 2007, was further developed in 2008 with alternatives refined and screened. A regional alternative scoring meeting was held in April. Alternatives were scored, with uncertainty levels included, according to survival criteria for forebay, concrete, tailrace, and post-Ice Harbor survival. A draft of the report was distributed for regional review in December 2008. That review is still under way. Other significant accomplishments included the following:

- **Removable Spillway Weir (RSW):** Actions to replace three of the five transition plates on the RSW were performed prior to the fish passage season. Additionally, design was completed on a follow-up contract to make miscellaneous improvements to the RSW so it is more easily maintained.
- **Ice Harbor Unit 2 Runner Replacement:** Significant progress on completing the turbine design and runner contract for Unit 2 was made in 2008. The contract scope includes design of two runner styles (fixed blade and adjustable blade). (The contract was advertised in spring 2009 and included design, manufacture and delivery of a fixed blade for Unit 2 as a base contract item, with an option to manufacture and deliver a second adjustable blade runner for Unit 3).
- **Evaluation of Survival and Passage Rates with Respect to Spill Operations:** A passage and survival study was conducted in 2008. The goal of this study was to provide passage and survival information at Ice Harbor Dam under spill treatments of 30 percent spill and 45 kcfs daytime spill/gas cap nighttime spill. Results will help determine future operations to meet BiOp performance standards at Ice Harbor.

  Non-turbine passage for spring migrants was 93 percent or more. For summer migrants, non-turbine passage was 96 percent. Survival estimates for 2008 were single-release estimates

because no fish were released below Ice Harbor. These are typically lower than paired-release estimates used in previous years and do not separate out mortality sustained between the Ice Harbor tailrace and the downstream point of detection. Survival estimates remained high in 2008 for all three species. Preliminary survival estimates show that performance standards from the 2008 BiOp may have been met or nearly met under all operations.

From 2008 preliminary data, juvenile Chinook salmon spill passage efficiency for 30 percent spill and 45 kcfs daytime spill/gas cap nighttime spill were 56 percent and 77 percent, respectively. Steelhead performed slightly higher with 77 percent and 89 percent respectively. During the summer there was not enough separation in spill patterns to distinguish them, yielding a combined spill passage efficiency of 66 percent.

Forebay retention times were 1 to 2 hours for all species with the exception of steelhead, which had a retention time of 4 hours under the 30 percent spill treatment.

RPA Action 23 – Configuration and Operation Plan for the Lower Monumental Project*: The Corps will consider all relevant biological criteria and prepare, in cooperation with NOAA Fisheries and the co-managing agencies, a Configuration and Operational Plan for the Lower Monumental Project (2010). As part of the first phase of modifications, the Corps will investigate, and implement the following reasonable and effective measures to reduce passage delay and increase survival of fish passing through the forebay, dam, and tailrace as warranted. Initial modifications will likely include:*

- *Primary bypass operations with PIT-tag detection installation to reduce handling stress of bypassed fish (2007)*
- *Juvenile bypass system outfall relocation to improve egress, direct and indirect survival on bypassed fish (2011)*
- *Turbine operation optimization to improve the survival of fish passing through turbines (2013)*
- *RSW installation to improve FPE, reduce forebay delay, and improve direct and indirect survival (2008)*
- *The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. The COP and modifications will be coordinated through the Regional Forum. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. If Phase I actions fail to meet the intended biological targets, Phase II actions will be considered for further implementation.*

The COP for Lower Monumental Dam is scheduled for completion in 2010; however, a significant configuration change was completed and biological performance testing was performed in 2008, as described below:

- **RSW** – Construction was completed on the RSW prior to the 2008 juvenile fish migration season. This surface passage route provides a more benign alternative to passing fish below the tainter (radial) gates during spill operations. Other benefits include attraction flow near the surface where juveniles are known to migrate. The attraction flow reduces forebay delay and increases spillway passage efficiency.
- **Evaluation of Survival and Passage Rates with Respect to Spill Operations** – An RSW post-construction passage and survival study conducted in 2008 compared two spill treatments, bulk spill versus a flat spill pattern. The yearling Chinook salmon relative survival estimate for concrete passage for the bulk spill pattern was 96.9 percent in 2008 but only 94.4 percent during the flat spill pattern. The lower overall relative survival numbers during flat spill were largely due to lower survival through the juvenile bypass system, which accounted for only 27 percent of the passage, with a relative survival of 88.6 percent. Survival estimates for the spillway were equal to or better than the performance standards, with the RSW exceeding all other passage routes. Steelhead relative survival estimates for concrete passage exceeded the spring performance standard for the bulk (100.3 percent) and flat (99.8 percent) spill

patterns in 2008. Subyearling Chinook salmon, sampled during the summer months, also exceeded the summer migrant performance standard criteria, with the bulk spill pattern operating (94.1 percent).

The RSW post-construction evaluation will continue in 2009 with the same two treatment tests. A study to determine the approaching depth of fish entering the RSW also will be conducted. The depth of balloon-tagged fish tested in 2008 indicated a higher level of injury among fish released close to the RSW (1.5 feet above the ogee) as opposed to fish released higher (6.5 feet above the ogee) of 12.8 percent and 2.2 percent, respectively. The vertical distribution study will determine the proportion of the migrant population, if any, that may be at higher risk of injury because of their approach depth.

Biological test results from the 2008 and 2009 fish passage seasons will be used to inform the discussions on future configuration and operational changes during preparation of the COP in 2010.

RPA Action 24 – Configuration and Operation Plan for the Little Goose Project*: The Corps will consider all relevant biological criteria and prepare, in cooperation with NOAA Fisheries and the co-managing agencies, a Configuration and Operational Plan for the Little Goose Project (2009). As part of the first phase of modifications, the Corps will investigate, and implement the following reasonable and effective measures to reduce passage delay and increase survival of fish passing through the forebay, dam, and tailrace as warranted. Initial modifications will likely include:*

- *Turbine operation optimization to improve the survival of fish passing through turbines (2014)*
- *Primary bypass operations with PIT-tag detection installation to reduce handling stress of bypassed fish (2008)*
- *Primary bypass outfall relocation to improve egress, direct and indirect survival on bypassed fish (2009)*
- *Surface spillway weir and deflector installation to improve FPE, reduce forebay delay and improve direct and indirect survival (2009)*
- *The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. The COP and modifications will be coordinated through the Regional Forum. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. If Phase I actions fail to meet the intended biological targets, Phase II actions will be considered for further implementation.*

Significant progress on configuration changes at Little Goose Dam was made during 2008. Remaining actions that may be necessary at this project will be evaluated during preparation of the COP in 2009. Accomplishments made in 2008 are as follows:

- **Spillway Weir** – Design of an adjustable spillway weir was completed, and a contract was awarded for construction. The spillway weir will be in service for the 2009 juvenile fish passage season, and its completion will result in a surface passage route at each of the Corps' eight Columbia and Snake River Dams. This is the first spillway weir that incorporates an adjustable flow feature that allows the flow over the weir to be higher for spring runoff conditions and lower for summer runoff conditions.

- **Spill Deflectors** – In conjunction with the spillway weir, design was completed and a contract awarded for installation of spill deflectors in Bay 1 (spillway weir bay) and Bay 8 at Little Goose Dam. The new deflectors are designed with a longer radius curve, which is expected to reduce potential injury to fish in addition to reducing TDG production. The addition of a deflector in Bay 8 also provides greater operational flexibility during voluntary spill conditions.

- **Juvenile Bypass System Full Flow PIT-Tag Monitoring** – A contract was awarded and construction initiated on the installation of a juvenile PIT-tag monitoring system in the full flow section of the primary bypass. The system provides PIT-tag detections while avoiding potential stressors in the facility and bypassing fish back to the river. (The system was completed before the 2009 juvenile fish migration season).

- **Juvenile Bypass Outfall Relocation** – Construction was initiated on the relocation of the bypass outfall in late 2008. The relocation will be completed during the 2009–2010 juvenile bypass system winter maintenance period. The relocated outfall will release fish in an area with higher river velocities and consistent downstream flow during all operations. This relocation is expected to decrease predation on the bypassed fish.

RPA Action 25 – Configuration and Operation Plan for the Lower Granite Project*: The Corps will consider all relevant biological criteria and prepare, in cooperation with NOAA Fisheries and the co-managing agencies, a Configuration and Operational Plan for Lower Granite Project (2009). As part of the first phase of modifications, the Corps will investigate, and implement the following reasonable and effective measures to reduce passage delay and increase survival of fish passing through the forebay, dam, and tailrace as warranted. Initial modifications will likely include:*

- *New juvenile fish facility including orifice configuration changes, primary dewatering, holding for transport, and primary bypass to improve direct and indirect survival for all collected fish (2012)*
- *Turbine operation optimization to improve survival of turbine passed fish (2014)*
- *The COP will be updated periodically and modifications may be altered as new biological and engineering information is gathered. The COP and modifications will be coordinated through the Regional Forum. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. If Phase I actions fail to meet the intended biological targets, Phase II actions will be considered for further implementation.*

Work began on the COP for Lower Granite in 2008. A regional brainstorming session was held in May that led to formation and description of alternatives. Evaluation criteria also were developed and will be used to evaluate the alternatives in 2009. The alternative(s) to be implemented will likely target increased survival of summer subyearling Chinook migrants. This is based on extensive passage and survival studies conducted between 2002 and 2007, which found that spring migrant dam passage relative survival estimates were generally equal to or higher than the BiOp performance standard of 96 percent. Summer migrants, however, have generally been estimated to survive at a lower rate, typically between 85 percent and 93 percent. The relative survival of fish passing over the RSW is usually higher than that of other passage routes. When this alternative is implemented, passage and survival evaluations will be conducted to determine whether Lower Granite is meeting BiOp performance standards.

Juvenile Fish Facility (JFF) Upgrade – Efforts continued toward completing the Engineering Design Report on modifications to upgrade the JFF at Lower Granite. A major focus was a value engineering study to identify areas where estimated construction costs could be reduced. An additional goal of this study was to evaluate new ideas that could improve on the design to add operational flexibility, reduce handling and stress of fish, and decrease construction costs by varying operations during construction. Study recommendations are being evaluated, and the final Engineering Design Report is expected in 2009. In addition to improvements for juvenile salmon, features to improve the separation, handling, holding, and transportation of steelhead kelts also are part of this upgrade. The biological benefits and costs of this action will be evaluated thoroughly during the COP process. Final design of this facility will be contingent on this action being identified as a preferred alternative.

RPA Action 26 – Chief Joseph Dam Flow Deflectors*: The Corps will complete the flow deflector construction at Chief Joseph Dam by 2009.*

Deflector construction was initiated in 2005 in response to RPA Action 136 in the 2000 Biological Opinion and previous discussions on the importance of these deflectors. Chief Joseph Dam does not have spill for fish passage, but water is spilled at this project and Grand Coulee in order to pass high flows. Investigations by the Corps concluded that installing flow deflectors at Chief Joseph Dam, which

is immediately downstream of Grand Coulee, and shifting spill and power generation between the projects is the most cost-effective alternative for gas abatement at these two dams.

Construction of flow deflectors on all 19 spillway bays at Chief Joseph was completed in September 2008, completing the structural component of the two-part alternative to reduce TDG downstream of Chief Joseph and Grand Coulee dams. (A successful spill test was carried out in spring 2009).

RPA Action 27 – Turbine Unit Operations*: The Action Agencies will operate turbine units to achieve best fish passage survival (currently within 1 percent of best efficiency at mainstem dams on the Lower Columbia and Lower Snake rivers from April 1–October 31 (hard constraint) and from November 1–March 31 (soft constraint) each year. Continue turbine operations evaluations and apply adaptive management to operate units in their optimum configuration for safe fish passage.*

Work continued to develop new turbine designs for safer fish passage. Studies on the effects of rapid decompression on fish injury and survival were completed in 2008. These results, along with physical model study results, are being used to develop a new turbine design for Ice Harbor Dam.

Work also continues to determine the safest operating point for fish passing through existing FCRPS turbines. Studies on rapid decompression, physical model studies, and numerical model studies were conducted in 2008 to further this understanding.

An alternatives study was initiated in 2008 to assess the feasibility of directly capturing juvenile fish that have passed through a mainstem dam turbine. If feasible, this method would provide a means of directly assessing turbine mortality, including capturing the effects of rapid decompression.

Hydropower Strategy 2 (RPA Action 28)

RPA Action 28 – Columbia and Snake River Project Adult Passage Improvements*: The Corps will implement the following structural improvements to adult passage at the mainstem Columbia and Snake river projects:*

- *Bonneville Dam*
    - *Improve the Bradford Island ladder system to reduce stress and improve reliability of upstream adult passage (2013).*
- *The Dalles Dam*
    - *East ladder emergency auxiliary water supply system and/or modifications that return adult salmon and steelhead use of the North ladder to pre-spillwall conditions to improve reliability of upstream adult passage (2013).*
- *John Day Dam*
    - *Adult ladder systems modifications to improve upstream adult passage conditions (2011).*
- *Ice Harbor Dam*
    - *Repair or replace north shore fishway auxiliary water supply (AWS) equipment as needed so that any two of the three pumps can meet flow criteria.*
- *Little Goose Dam*
    - *Investigate adult passage and determine whether structural, operational, or tailrace modifications can alleviate adult passage delays or blockages during spill operations for optimum juvenile passage (See RME Action 54).*
- *Lower Granite Dam*
    - *Investigate and if necessary provide additional auxiliary water supply for the new adult trap at lower Granite so that it can operate at full capacity when the forebay is operated at MOP without affecting the fishway AWS (2012).*
    - *Adult fishway modification to improve upstream adult passage conditions impaired by temperature differentials (need will be determined by results of further research) (prototype 2011).*

The following progress was made toward improving adult passage at the mainstem Columbia and Snake River projects:

- **The Dalles:** Evaluation continued in 2008 of alternatives for adult east ladder emergency auxiliary water supply and/or restored use of the north ladder. Additional efforts on the north ladder have been deferred pending spillwall completion and spillway operations to evaluate the effects of the new configuration and operations on adult use of this facility.
- **John Day:** Efforts continued to develop improved entrance and passage conditions in the north fish ladder. In 2008, the following was accomplished:

Completed an entrance/Auxiliary Water System (AWS) alternatives study. Initiated the design documentation report.

Completed the design documentation report for the exit section and count station modification alternatives. Initiated plans and specifications for planned fiscal year 2010 construction start.

- **Ice Harbor North Shore Adult Fish Ladder AWS:** Warranty replacement of two of three gear shafts on the north shore auxiliary water supply pumps was completed in fall 2008. These actions will allow the system to meet the hydraulic criteria outlined in the fish operations plan. (Replacement of the third gear shaft was completed in early 2009).
- **Little Goose Adult Passage Delays:** Adult migration at Little Goose was slowed significantly during high-volume summer spill in 2005 and bulk pattern spill in spring 2007. A 2008 study to determine the cause of adult passage used two bulk patterns (to mimic a surface passage structure) and a uniform pattern that mimicked the anticipated training spill for a surface passage structure. Data indicated that adult passage percentage is slightly higher through the north shore ladder than the south shore, with about 10 percent of the adults entering the north powerhouse entrance near the dam's center. The uniform pattern produced the shortest median times from first tailrace record to first fishway approach, produced the highest percentage of first fishway approaches resulting in fishway entrance and produced the shortest median time from first tailrace record to last record at the top of the fish ladder.
- **Lower Granite Ladder Temperature Monitoring:** In 2008, the water temperatures within the Lower Granite fish ladder were monitored to identify areas of temperature gradients. In addition, radio-tagged adult salmon were monitored to determine whether there was a correlation between passage delays and large temperature differentials within the ladder. Generally, fish passed through the ladder more slowly when temperatures were higher than 18°C. In 2008, there were only two days when the temperature differential between the bottom and top of the ladder exceeded 1°C; consequently, the relationship between temperature differentials and salmon behavior could not be fully assessed. Data from this and future research will help determine whether future modifications to the ladder to introduce cooler water during the late summer are required.

Hydropower Strategy 3 (RPA Actions 29–31)

RPA Action 29 – Spill Operations to Improve Juvenile Passage*: The Corps and BPA will provide spill to improve juvenile fish passage while avoiding high TDG supersaturation levels or adult fallback problems. Specific spill levels will be provided for juvenile fish passage at each project, not to exceed established TDG levels (either 110 percent TDG standard, or as modified by State water quality waivers, currently up to 115 percent TDG in the dam forebay and up to 120 percent TDG in the project tailwater, or if spill to these levels would compromise the likelihood of meeting performance standards (see RPA action table, RME Strategy 2). The dates and levels for spill may be modified through the implementation planning process and adaptive management decisions. The initial levels and dates for spill operations are identified in Table 2 of the RPA action table. Future Water Management Plans will contain the annual work plans for these*

operations and spill programs, and will be coordinated through the TMT. The Corps and BPA will continue to evaluate and optimize spill passage survival to meet both the hydrosystem performance standards and the requirements of the Clean Water Act (CWA).

Spill Operations

Spill operations for 2008 are reported in the 2008 Dissolved Gas and Water Temperature Monitoring Report (ACOE 2008d, at *http://www.nwd-wc.usace.army.mil/tmt/wq/tdg_and_temp/2008/*). This report describes the Corps' water quality monitoring program for 2008 and covers the lower Columbia and Snake River projects. The report provides information consistent with the TDG waiver issued by Oregon and the criteria adjustment by Washington. The report also includes the following additional technical information:

- Flow and runoff conditions for the spill season
- Duration and volume of spill for fish passage versus spill for other reasons for each project
- Data from the physical and biological monitoring programs, including incidences of gas bubble trauma (GBT)
- Description and results of any biological or physical studies of spillway structures and prototype fish passage devices to test spill at operational levels
- Progress on implementing measures contained in the lower Columbia and lower Snake River total dissolved gas TMDL documents.

The report focuses on the water quality monitoring of TDG and temperature at the 12 Corps dams in the Columbia River Basin.

Spring Spill

During 2008, spring spill at the lower Columbia and Snake River projects met the 2008 Fish Operations Plan (FOP) (*http://www.nwd-wc.usace.army.mil/tmt/documents/ops/FOP/FOP%202008%20final.pdf*). Spring spill began April 3 and continued through June 20 at the lower Snake River projects. Spring spill began April 10 and continued through June 21 at McNary, John Day, and Bonneville dams and continued to June 30 at The Dalles Dam.

The 2008 FOP called for the following spill operations during the spring:

- Lower Granite: 20 kcfs, 24 hours per day
- Little Goose: 30 percent of river flow, 24 hours/day, plus 14 days of spill to the spill cap between April 22 and May 15
- Lower Monumental: to the spill cap (estimated to be approximately 27 kcfs), 24 hours/day
- Ice Harbor: spill alternating between 30 percent of the river flow 24 hours/day or 45 kcfs during the day and up to the spill cap at night
- McNary: 40 percent of the project outflow.
- John Day: 60 percent of total outflow during the night with no spill during the day from April 10 through April 20, 30 percent of outflow from April 21 through May 1, and alternating between 30 percent and 40 percent of total outflow from April 21 through June 20
- The Dalles: 40 percent of the project outflow
- Bonneville: to the gas cap up to100 kcfs

Total river flows remained elevated on the Columbia River from the third week of May to the first week of July, when the freshet occurred. Total river flows on the Columbia River during this period ranged from a daily average flow of 276 kcfs to 418 kcfs, with an overall daily average flow of 402 kcfs. These flows were lower than in 2007, when the daily average flow was between 250 and 300 kcfs. Flow began to taper off in July and August. Total river flows remained elevated on the Snake River from May to early July, when the freshet occurred there. Total river flows on the lower Snake River from early May to early July ranged from a daily average flow of 62 kcfs to 199 kcfs, which is similar to 2006, when the flow was between 83 and 200 kcfs.

Summer Spill

During 2008, summer spill began June 21 and continued through August 31 at the lower Snake River projects and at McNary, John Day, and Bonneville dams on the lower Columbia River. Summer spill at The Dalles on the lower Columbia River began July 1 and continued through August 31.

The 2008 FOP called for the following spill operations during the summer:

- Lower Granite: 18 kcfs, 24 hours/day
- Little Goose: 30 percent of river flow, 24 hours/day
- Lower Monumental: 17 kcfs, 24 hours/day
- Ice Harbor: spill alternating between 30 percent of the river flow 24 hours/day or 45 kcfs during the day and up to the spill cap at night
- McNary: spill alternating between 40 percent and 60 percent of the project outflow
- John Day: spill alternating between 30 percent and 40 percent of total outflow from June 21 through July 18, then 30 percent of outflow from July 19 through August 31
- The Dalles: 40 percent of the project outflow
- Bonneville: spill 85 kcfs during the day and to the spill cap at night from June 21 through July 20. Spill 75 kcfs during the day and to the spill cap at night from July 21 through August 31.

Total river flows continued to be high on the Columbia River during July and tapered off in August. Total river flows on the Columbia River during July were between a daily average of 156 and 327 kcfs, with an overall daily average flow of 212 kcfs, which was much higher than in 2007 (174 kcfs) or 2006 (184 kcfs). Total river flows on the Columbia River during August were average at 135 kcfs. Total river flows continued to be high in July and began to taper off in August on the Snake River. Total river flows on the Snake River during the July-August period were between a daily average flow of 26 and 143 kcfs, with a summer average flow of 56 kcfs; this is high compared to 2007 (28 kcfs) and 2006 (37 kcfs).

Total Dissolved Gas (TDG) Exceedances

When providing spill for fish passage, dam operators direct some water through the spillways instead of sending all of it through the turbines. At large dams, spilled water plunges to the river with enough force to supersaturate atmospheric gases in the water. These gases can build up to levels that are dangerous to salmon and other aquatic life. The Corps coordinates with the states of Washington and Oregon on total dissolved gas criteria that accommodate voluntary spill for fish passage resulting in TDG levels of up to 120 percent of saturation in dam tailraces or 115 percent of saturation in the forebay of the next dam downstream (measured as a 12-hour average).

Depending on the location and the time of day, spill for fish passage may be specified as a set amount of flow or as spill to the "gas cap," meaning up to the state TDG standards. The maximum amount of spill projected not to result in a TDG level higher than the state TDG standards is known as the "spill cap" and changes with environmental conditions. The process of establishing daily spill caps entails reviewing existing hourly data at each dam (including flow, spill, temperature, and incoming TDG levels) and taking into consideration a number of forecast conditions (including total flow, flow through the powerhouse, wind and temperature forecast, etc.). This information is used as input into the SYSTDG (System TDG) modeling tool. The SYSTDG model estimates TDG levels in the rivers several days into the future and is integral to daily decision-making when establishing spill caps at individual dams.

Exceedances of the state TDG standards can result from voluntary spill for fish passage. There is an element of professional judgment involved in setting spill caps, and flow, wind, and temperature forecasts used to set spill caps are not always accurate. However, most instances in which the TDG levels are higher than the standard are the result of involuntary spill, meaning spill resulting from high river flows exceeding powerhouse hydraulic capacity; these may occur in addition to fish passage spill. In addition, powerhouse hydraulic capacity may be reduced as a result of turbine unit maintenance outages or low electrical power demand, especially during low demand hours at night and on weekends. Either can result in additional water (beyond the spill cap amount) being spilled, with resulting TDG levels higher than the standard.

During the 2008 fish passage spill season, there were 93 gauge-day exceedances of Washington and Oregon TDG criteria as a result of voluntary spill operations for fish, out of 2,504 possible daily occurrences ([number of TDG gauges] x [days in spill season, April 3 through August 31]).

- 64 were caused by uncertainties in best professional judgment in setting spill caps.
- 12 resulted from sharp, unforecasted increases in water temperature.
- 11 resulted from gauges malfunctioning and reporting very high TDG levels.
- 5 resulted from bulk spill patterns generating more TDG than expected.
- 1 resulted from a mechanical problem.

There were another 422 instances in which TDG levels were higher than the Washington and Oregon standards, but the exceedances were not associated with voluntary spill for fish:

- 400 resulted from high runoff flows or flood control operations.
- 21 resulted from high TDG levels coming from the Mid-Columbia River projects.
- 1 resulted from a turbine unit outage.

During the 2008 migration season, there also were 668 instances in which TDG levels were higher than either the Oregon 1-hour standard or Washington 2-hour standards of 125 percent TDG. A total of 652 of those instances resulted from involuntary spill that was due to high runoff. The other 16 resulted from special spill operations to pass woody debris. Woody debris in project forebays negatively affects project operations and can have a deleterious effect on fish, as the debris often accumulates in or near juvenile bypass systems and on dewatering screens. The buildup can cause injury or mortality of juvenile salmonids. Typical debris spill operations require opening individual spillbays far enough to allow floating debris to pass under the gates. Opening spill gates that far can elevate TDG levels for a short period of time (usually from 1 to 4 hours) during the operation.

RPA Action 30 – Juvenile Fish Transportation in the Columbia and Snake Rivers*: The Corps and BPA will continue the juvenile fish transportation program toward meeting system survival performance metrics of Snake and Columbia River salmon and steelhead with some adaptive management modifications based on results of RME. The Corps and BPA will continue to collect and transport juvenile fish at Lower Granite, Little Goose, Lower Monumental, and McNary dams, although under a modified operation as described in Table 3 and Table 4 of the RPA action table. While the dates mentioned in this section should be considered firm planning dates, if in-season information or results of ongoing RME indicates a need for adaptive management (for example, if modifying these dates are likely to increase in-river or system survival and would be likely to provide equivalent or increased SARs of the species transported), the Action Agencies will consider revising the dates and operations through the Regional Forum.*

The 2008 transportation program was conducted in accordance with NOAA ESA Permit Number 1237 and the Juvenile Fish Transportation Program criteria in the Corps' 2008 Fish Passage Plan. The start dates for initiating transport operations were staggered at Snake River operating projects. Collection of juvenile fish for transportation began May 1 at Lower Granite Dam, May 9 at Little Goose Dam, and May 12 at Lower Monumental Dam. Before transport began, sampling operations took place at the Lower Granite, Little Goose, and Lower Monumental facilities in support of research activities, BPA-sponsored smolt monitoring activities, and assessment of bypass system conditions, Smolt Monitoring Program activities took place daily at Lower Granite Dam throughout the entire season. Transport operations at the Snake River facilities continued through September 30 at Lower Monumental Dam and through November 1 at Little Goose and Lower Granite dams.

Fish at McNary Dam were bypassed from April 1 through July 16 and transported from July 16 to September 22. Sampling operations took place on an every-other-day basis from April 2 through August 16 to support research and BPA-sponsored smolt monitoring activities, as well as to assess bypass system conditions. Juvenile fish transportation by barge began July 17 and continued through August 16. Juvenile fish transportation by truck began August 17 and continued through September 22. Fish collected for transport at McNary Dam from September 22 through 25 were bypassed to the river because of excessive numbers of shad in the collection.

Juvenile fish barged during 2008 were released at varying locations below Bonneville Dam as required in the permit. The ending date for the barging season in 2008 for Snake River fish was August 15. Trucks carried juvenile fish from August 17 through the end of the transport season. Fish were released from a newly constructed truck pad into the Bonneville Juvenile Monitoring Facility outfall flume. In past years, trucks were driven onto barges and transported to mid-channel to release their fish. No early season (April) trucking took place in 2008.

Estimates of the number of fish collected, bypassed, and transported as part of the juvenile fish transportation program are based on sampling portions of the fish collected. Sampled numbers were expanded according to the percentage of the time sampled. At Snake River operating projects, the sampled fish were hand counted and differentiated by species and whether or not adipose fins were clipped. A total of 5,082,176 juvenile fish were collected at Lower Granite Dam, with 815,565 of these fish bypassed to the river and 4,252,195 transported. At Little Goose Dam, 4,885,642 juvenile salmon and steelhead were collected in 2008. Of these, 1,114,654 were bypassed back to the river, and 3,764,974 were transported. At Lower Monumental Dam, 2,097,408 juvenile salmon and steelhead were collected in 2008. Of these, 1,330,880 fish were bypassed, and 765,489 were transported. At McNary Dam, 2,395,116 juvenile salmon and steelhead were collected in 2008. Approximately 1,959,114 of the fish collected were bypassed back to the river to meet fishery agency requirements, and 425,743 juvenile fish were transported. Many collected fish at each project were used for research purposes. Consequently, not all collected fish were bypassed to the river or transported.

A total of 14,460,342 juvenile salmon and steelhead were collected at all transport program locations in 2008, with 9,208,401 fish transported (64 percent) and 5,250,143 bypassed (36 percent). Of the

fish transported, 9,095,546 were transported by barge (99 percent) and 112,855 were trucked (1 percent).

The estimated proportion of non-tagged spring/summer Chinook salmon smolts transported across the entire season in 2008 was 54.3 percent for wild fish and 45.3 percent for hatchery fish. For non-tagged steelhead, the estimated proportions transported were 50.5 percent and 46.6 percent for wild and hatchery smolts, respectively (Faulkner et al., 2009).

Table 2. Estimated Proportion of Non-Tagged Spring/Summer Chinook and Steelhead Smolts Transported in the Columbia and Snake Rivers in 2008.

Species	Percent Transported in 2008
Snake River Spring Chinook—Wild	54.3%
Snake River Spring Chinook—Hatchery	45.3%
Snake River Spring Steelhead—Wild	50.5%
Snake River Spring Steelhead—Hatchery	46.6%

The juvenile fish passage facilities also bypass adult salmon and steelhead from the juvenile fish separators back to the river. A total of 14,737 adult fallbacks were handled; these included 5,646 at Lower Granite Dam, 6,201 at Little Goose Dam, 1,206 at Lower Monumental Dam, and 1,684 at McNary Dam. Of these, 1,034 fish were spring/summer Chinook, 4,134 were fall Chinook, 9,379 were steelhead, 131 were sockeye, and 59 were coho.

RPA Action 31 – Configuration and Operation Plan Transportation Strategy*: The Corps, in coordination with the Regional Forum, will initiate a Configuration Operational Plan in 2009. The plan will be completed in 2010 and will present a strategy for prioritizing and carrying out further transportation actions at each dam. Comments developed by NOAA Fisheries on the draft COPs shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final COP. Construction actions for transportation are primarily in the context of changes to juvenile bypass systems. Changes meant to increase adult salmon returns through the juvenile fish transportation process are being evaluated. Some changes include additional barges, a new juvenile fish facility at Lower Granite Dam and modifications to the juvenile fish facilities at Little Goose, Lower Monumental and McNary dams.*

Various studies continued in 2008 to inform the Transportation Strategy COP, slated for completion in 2010. The data will be used to evaluate operational and construction alternatives to improve the transportation program. Significant among these were the following studies:

- **Differential Delayed Mortality.** Comparative studies evaluating the smolt-to-adult return (SAR) rates of fish with in-river migration life histories versus those that are barged continued in 2008. The goal of this work is to identify management options that will optimize in-river and barging operations to maximize SARs, taking into consideration predation, disease concerns associated with barging, and ocean entry timing.
- **Fish Transportation Spring Migrants**. The Action Agencies continued research to determine the potential of transportation to increase adult returns of anadromous salmon in 2008. A PIT-tag study to evaluate weekly SARs for natural spring Chinook and steelhead transported from Lower Granite Dam continued in 2008. More precise transportation data in the April time frame should help clarify effects of transportation on early migrating fish. More precise data in the May time frame should allow for correlation of physical and environmental factors to guide Action Agencies on appropriate triggers of how to operate transportation on an annual basis toward maximizing adult returns. This study included a comparison of SARs for transported and in-river

migrants using reach survival study fish as the in-river group. Results from this study will be available in 2011 and 2012.

- **Fish Transportation Summer Migrants**. In 2008, the Action Agencies continued implementing the 2007 fall Chinook salmon consensus transportation proposal and long-term framework developed collaboratively by the Idaho Department of Fish and Game, Nez Perce Tribe, National Marine Fisheries Service (NOAA Fisheries), Oregon Department of Fish and Wildlife, and U.S. Fish and Wildlife Service. This intensive research, monitoring, and evaluation effort for subyearling fall Chinook salmon will help determine the appropriate management strategy to optimize adult returns. Results from PIT-tag groups of fish in 2008 will be available in 2012–2013.

Hydropower Strategy 4 (RPA Action 32)

RPA Action 32 – Fish Passage Plan*: The Corps will annually prepare a FPP in coordination with NOAA Fisheries and the Regional Forum through the FPOM. The Corps will operate its projects (including juvenile and adult fish passage facilities) year-round in accordance with the criteria in the FPP. Comments developed by NOAA Fisheries on the draft FPP shall be reconciled by the Corps in writing to NOAA Fisheries' satisfaction before release of the final FPP.*

The draft 2008 Fish Passage Plan was released in October 2007; the final *Fish Passage Plan, Corps of Engineers Projects, EDNWD-NDW-R* (ACOE 2008b, at *http://www.nwd-wc.usace.army.mil/tmt/documents/fpp*) was released in March 2008.

Hydropower Strategy 5 (RPA Action 33)

RPA Action 33 – Snake River Steelhead Kelt Management Plan*: The BPA and Corps will prepare a Snake River Kelt Management Plan in coordination with NOAA Fisheries and the Regional Forum. The BPA and Corps will implement the plan to improve the productivity of interior basin B-run steelhead populations.*

Several actions were taken in 2008 to enable development of a Kelt Management Plan in 2009. The Corps and BPA met in Walla Walla in February 2008 to discuss the kelt work that would likely take place in 2009. Lower Granite was identified as the primary collection point for this work. BPA noted that a contractor would be performing the work at Lower Granite. Possible transport of kelts also was discussed. This meeting was followed by a site visit to Lower Granite Dam to discuss collection and holding. Two additional meetings with CRITFC and University of Idaho personnel were held at the Lower Granite and Dworshak Fish Hatchery in December 2008. The meetings addressed plans for kelt collection activities at the juvenile fish facility and potential reconditioning efforts at the Dworshak Fish Hatchery in 2009.

Implementation

BPA has funded CRITFC to prepare a Master Plan for kelt (BPA project number 2007-401-00), which could provide the detail on the reconditioning topic in the broader Kelt Management Plan. The Master Plan will focus on kelt collection and reconditioning at various locations. CRITFC has subcontracted portions of this project out to the University of Idaho. Preparing a Kelt Master Plan is one deliverable that CRITFC will provide as part of its contract with BPA. The Kelt Master Plan — which will apply to reconditioning Snake River kelts — is part of a three-step technical review process required by the Council for artificial propagation projects, particularly those that affect natural populations and involve construction of capital facilities.

Habitat Implementation Reports, RPAs 34–38

Table 3. Habitat Strategy Requirements, RPA Actions 34–38

RPA No.	Action	Annual Progress Report Requirement
Habitat Strategy 1		
34	Tributary Habitat Implementation 2007 to 2009 – Progress Toward 2018 Habitat Quality Improvement Targets	Status of project implementation (including project milestones) through December of previous year for all 2007-2009 actions. Report physical metrics for implementation achieved (e.g., miles of access, cfs of streamflow acquired, numbers of screens, miles or acres of habitat protected or enhanced, and miles of complexity enhanced) relative to the project objectives.
35	Tributary Habitat Implementation 2010-2018 – Achieving Habitat Quality and Survival Improvement Targets	• Status of project implementation (including project milestones) through December of previous year for all actions identified in implementation plans. • Report physical metrics for implementation achieved (e.g., miles of access, cfs of streamflow acquired, numbers of screens installed, miles of acres of habitat protected or enhanced, and miles of complexity enhanced by benefited population(s)) relative to the total needed to complete the project and achieve the estimated survival benefits, by project.
Habitat Strategy 2		
36	Estuary Habitat Implementation 2007 to 2009	• Status of project implementation (including project milestones) through December of previous year for all 2007-2009 actions. • Report physical metrics for implementation achieved (e.g., number of acres protected/restored/enhanced; riparian miles protected) relative to the total needed to complete project and achieve the estimated survival benefits.
37	Estuary Habitat Implementation 2010-2018 – Achieving Habitat Quality and Survival Improvement Targets	• Status of project implementation (including project milestones) through December of previous year for all actions identified in implementation plans. • Report physical metrics for implementation achieved (e.g., number of acres protected, restored, enhanced; riparian miles protected) relative to the total needed to complete the project and achieve the estimated survival benefits, by project. • By ESU, report progress toward ESU/DPS-specific survival benefit. • Where ESU/DPS-specific survival benefits are not achieving the progress guidelines above, identify processes or projects in place to ensure achievements by the next comprehensive report.

Table 3. Habitat Strategy Requirements, RPA Actions 34–38

RPA No.	Action	Annual Progress Report Requirement
38	Piling and Piling Dike Removal Program	• Status of project implementation (including project milestones) through December of previous year for all actions identified in implementation plans. • Report physical metrics for implementation achieved (e.g., number of pilings/pile dikes removed, habitat area restored) by project.

Habitat Strategy 1 (RPA Actions 34–35)

RPA Action 34 – Tributary Habitat Implementation 2007 to 2009*: Progress Toward 2018 Habitat Quality Improvement Targets: The Action Agencies will provide funding and technical assistance necessary to implement the specific projects identified for implementation in 2007 to 2009 as part of a tributary habitat program to achieve the population-specific overall habitat quality improvement identified in Table 5 of the RPA action table.*

RPA Action 34 specifies requirements for the 3-year cycle from 2007 to 2009. Detailed information on the 2008 progress of individual projects and actions is presented in Section 4, Attachment 3, Tables 1 through 6. The projects and actions listed in Tables 1 through 6 were identified as implementation commitments in the 2007 FCRPS Biological Assessment. NOAA used these actions in its jeopardy analysis and to finalize RPAs 34 and 35 in the BiOp. The tables are organized by ESU and DPS and include project descriptions and habitat metrics that were completed in 2007 and 2008. Projects may be reported multiple times if they benefit more than one species or more than one population.

It should be noted that the metrics included in these tables are not yet consistent with the Katz et al. metrics described in RPA Action 73. The actual metrics reported will evolve as the Action Agencies, working with regional forums, develop a comprehensive system to collect, store, and report tributary habitat action implementation information consistent with the guidance provided in Katz et al. (2006). The Action Agencies will eventually track and report habitat metrics appropriate for their respective habitat programs that are consistent with the Katz et al. metrics.

The Population Summary in Section 4, Attachment 2, summarizes metrics completed in 2007 and 2008 that are related to the populations listed in the 2008 BiOp RPA 35, Table 5. Attachment 2 is included to provide an overview of implementation progress relative to the population-specific biological needs presented by state and tribal partners.

RPA Action 35 – Tributary Habitat Implementation 2010–2018*: Achieving Habitat Quality and Survival Improvement Targets: The Action Agencies will identify additional habitat projects for implementation based on the population specific overall habitat quality improvement still remaining in Table 5 of the RPA action table. Projects will identify location, treatment of limiting factor, targeted population or populations, appropriate reporting metrics, and estimated biological benefits based on achieving those metrics. Pertinent new information on climate change and potential effects of that information on limiting factors will be considered.*

Annual progress for projects implemented under RPA Action 35, which specifies requirements for 3-year cycles between 2010 and 2018, will be reported in future progress reports.

However, one of the 2008 BiOp's key improvements over previous BiOps is the expanded use of population-specific biological information to target actions in combination with the use of on-the-ground experts to identify and prioritize tributary habitat projects and assess their biological benefits. In 2008 the "expert panel" process was initiated by the Action Agencies to address collaboration with states and tribes as recommended by the Oregon District Court and support the process called for in RPA Action 35.

The local expert panel process is being conducted in those areas where fish populations have the greatest biological need (as listed in RPA Action 35, Table 5): the Clearwater, lower Snake, Grande Ronde/Imnaha, upper Salmon, and upper Columbia (Wenatchee, Entiat, Methow, and Okanogan) geographic areas. The process will inform the 2010–2012 Implementation Plan that is due in December 2009 and provide input for the Action Agencies to assess habitat quality improvements for salmon and steelhead. Expert panel members will review the benefits associated with habitat actions completed between 2007 and 2009, revise those benefits if necessary, identify potential habitat improvement actions for the 2010–2012 implementation cycle, and associate biological benefits with the 2010–2012 actions (2008 FCRPS BiOp, RPA 35; 2007 FCRPS CA, Appendix C, Annex 1). Presentation of this information in upcoming Implementation Plans will illustrate the progress on commitments contained in RPA 35, Table 5 of the 2008 FCRPS BiOp.

In November 2008, the Action Agencies began holding meetings to inform local experts about the upcoming workshops that would be convened in 2009. In the orientation meetings, the Action Agencies provided an overview of tributary habitat FCRPS BiOp requirements, described the methods planned to gather input on 2007-2009 implementation of habitat actions, and described what would be needed for the 2010-2012 habitat implementation planning. The orientation meetings were held in LaGrande, Oregon; Lewiston, Idaho; Salmon, Idaho; and Wenatchee, Washington.

Attendees at the orientation meetings included representatives from NOAA Fisheries, tribal and state fish and wildlife agencies, the U.S. Forest Service, the U.S. Fish and Wildlife Service, local watershed groups, conservation districts, and recovery boards. All had extensive knowledge and experience about the local habitat conditions, and many hold undergraduate and advanced degrees in natural resource-related fields.

Additional Reports

Reclamation has produced a number of additional reports that document tributary habitat accomplishments. These reports are listed in Section 4, Attachment 3; the reports can be accessed by following links at *http://www.usbr.gov/pn/programs/fcrps/thp/index.html*.

Habitat Strategy 2 (RPA Actions 36–38)

RPA Action 36 – Estuary Habitat Implementation 2007 to 2009*: The Action Agencies will provide funding to implement specific actions identified for implementation in 2007–2009 as part of a 10-year estuary habitat program to achieve the estimated ESU survival benefits of 9.0 percent and 6.0 percent for ocean type and stream-type ESUs, respectively. Projects in an early state of development such that quantitative physical metrics have not been related to estimated survival benefits will be selected per Action 37. If projects identified for implementation in 2007–2009 prove infeasible, in whole or in part, the Action Agencies will implement comparable replacement projects in 2010–2013 to provide equivalent habitat benefits needed to achieve equivalent survival benefits.*

The Action Agencies expanded the level of on-the-ground implementation in 2008 with particular focus on projects that address biological priorities and key limiting factors identified for estuary habitat for all ESUs. Key limiting factors identified in NOAA's *Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead* include reduced in-channel and off-channel habitat changes, food source changes, and competition and predation. Project types include land acquisition; protection of off-channel habitats; reduction of invasive plants; and protection and restoration of riparian and wetland areas.

During 2008, the Action Agencies completed eight on-the-ground habitat projects with another three estuary habitat projects in the planning and development phase. On-the-ground actions include two land acquisitions: Willow Grove and Wolf Bay. Management plans, including future restoration activities, on the acquired parcels have been or are being put in place. Additional habitat activities include removing riparian/wetland invasive plant species and planting native species, installing fence

in riparian areas to exclude cattle, removing riprap, improving fish passage structures, and placing large wood material.

Project planning and development occurred on Deer Island, where design and landowner outreach were under way in 2008 for possible future implementation actions. Overall long-term restoration goals seek to restore historical estuarine habitats where feasible on the 4,500-acre island.

In 2008 the new Pile Structure Program was initiated. The purpose of this initial stage was to produce a draft program plan and begin to inventory and assess pile structures, develop draft criteria for establishing project priorities, and identifies future possible project implementation sites.

See Section 4, Attachment 5, for further detail on the estuary projects and metrics accomplished.

RPA Action 37 – Estuary Habitat Implementation 2010–2018 – Achieving Habitat Quality and Survival Improvement Targets*: The Action Agencies will provide funding to implement additional specific projects as needed to achieve the total estuary survival benefits identified in the FCRPS BA. Projects will identify location, treatment of limiting factor, targeted ESU/DPS or ESUs/DPSs, appropriate reporting metrics, and estimated biological benefits based on the achieving of those metrics. Pertinent new information on climate change and potential effects of that information on limiting factors will be considered.*

Some, but not all, of the suite of projects that will be implemented during 2010–2018 have been identified. However, the Action Agencies have committed to continuing to implement the expanded estuary habitat program from the previous time frame of 2007–2009. As the estuary studies continue to inform, the Action Agencies will be better able to target the amount and types of habitat that would help increase survival and better quantify the biological benefits of these actions. The goal is to implement actions that provide the greatest and most efficient biological benefit to all listed ESUs.

If identified habitat projects are not implemented for some reason, such as because of local sponsorship or real estate issues, the Action Agencies will work to identify alternative projects to provide the same or greater benefits. Projects will be selected using the process identified below for future implementation.

Projects for longer term implementation will be identified based on research and regional coordination. The Action Agencies will use the *Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead* (by NOAA Fisheries) to guide restoration and protection efforts through a collaborative process. Beginning in 2008, the Action Agencies initiated the development of a strategic approach to identifying restoration and protection projects in the estuary using a new Ecosystem Classification System being developed by the University of Washington and the U.S. Geological Survey (USGS). The strategic approach will use guiding principles based on salmonid ecology to identify potential sites with the highest value to salmon and steelhead. This is a collaborative effort between the Action Agencies and other regional interests, including the Lower Columbia River Estuary Partnership (LCREP), the states of Oregon and Washington, and local restoration practitioners, including the Columbia River Estuary Study Taskforce (CREST), the Cowlitz Tribe, the Columbia Land Trust, watershed councils, and conservation districts. When available, new scientific information resulting from FCRPS RME will be applied to estimate benefits for projects implemented between 2010 and 2018.

RPA Action 38 – Piling and Piling Dike Removal Program*: To increase access to productive habitat and to reduce avian predation, the Action Agencies will develop and implement a piling and pile dike removal program.*

In 2008, the Action Agencies, in collaboration with the Lower Columbia River Estuary Partnership, set up the Pile Structure Program subcommittee under the Estuary Partnership's Science Work Group. In 2008, the Action Agencies, in collaboration with others, began implementing the Pile Structure Program by gathering pile structure site condition data and designing a scientific approach to guide implementation.

In 2008 the Action Agencies made considerable progress on a draft program plan for the new Pile Structure Program. This document will be reviewed by the Independent Scientific Review Panel in 2009. Site-specific data collection and monitoring will begin in 2009 with on-the-ground implementation, including pile structure removal in 2010.

The Action Agencies conducted pre-monitoring at Coal Creek, a pile structure removal project funded and implemented by NOAA Fisheries in 2008. The Action Agencies' post-monitoring for this project will be completed in 2009. Pre- and post-monitoring for pile removal at the Coal Creek Project site included water quality monitoring of adjacent sediments, dissolved oxygen, and target analytes sampling. Concurrently, data were collected to investigate fish use, hydrology, and bathymetry at the removal site.

Hatchery Implementation Reports, RPA Action 39–42

Table 4. Hatchery Strategy RPA Action Requirements.

RPA No.	Action	Annual Report Requirement
Hatchery Strategy 1		
39	FCRPS Funding of Mitigation Hatcheries – Programmatic	Status of submittal/approval of Hatchery Genetic Management Plans (HGMPs), including site-specific application of BMPs.
40	Reform FCRPS Hatchery Operations to Reduce Genetic and Ecological Effects on ESA-Listed Salmon and Steelhead	• Status of implementation through December of the previous year for all reforms identified in Table 6. • Status of implementation of future reforms identified by the Action Agencies following the HSRG process.
Hatchery Strategy 2		
41	Implement Safety Net Programs to Preserve Genetic Resources and Reduce Short-term Extinction Risk	Status of implementation through December of the previous year for all safety net programs identified in Table 7.
42	Implement Conservation Programs to Build Genetic Resources and Assist in Promoting Recovery	Status of implementation through December of the previous year for all conservation programs identified in Table 6.

Hatchery Strategy 1 (RPA Actions 39–40)

RPA Action 39 – FCRPS Funding of Mitigation Hatcheries – Programmatic*: The FCRPS Action Agencies will continue funding hatcheries in accordance with existing programs, and will adopt programmatic criteria for funding decisions on mitigation programs for the FCRPS that incorporate BMPs. The Hatchery Effects Report, the August 2006 NOAA Fisheries paper to the PWG and the NOAA Fisheries 2007 Guidance Paper should be considered in developing these criteria in addition to the BMPs in the Action Agencies' BA. Site specific application of BMPs will be defined in ESA Section 7, Section 10, or Section 4(d) consultations with NOAA Fisheries to be initiated and conducted by hatchery operators with the Action Agencies as cooperating agencies.*

In 2008, the Action Agencies continued to fund mitigation hatcheries in accordance with existing programs and developed programmatic funding criteria for funding decisions on mitigation programs

for the FCRPS. These funding criteria will be used to inform future funding decisions on FCRPS mitigation hatchery programs.

In September 2008, NOAA Fisheries announced initiation of its RPA Action 39 ESA consultation process for upper Columbia hatchery programs. Subsequently, the Action Agency-funded hatchery operators in the upper Columbia region began updating the Hatchery and Genetic Management Plans (HGMPs) for their respective hatchery programs. Information from the reports of the recently completed USFWS Hatchery Review Team process and the Hatchery Scientific Review Group will guide and inform the development of program-specific HGMPs. As of December 2008, development of updated HGMPs for all FCRPS hatchery programs in the upper Columbia requiring consultation (Table 5) was under way.

Table 5. FCRPS-Funded Hatchery Programs in the Upper Columbia Region.

Program	Operator	Lead Action Agency	Basin
Leavenworth National Fish Hatchery (NFH) spring Chinook	USFWS	Reclamation	Wenatchee
Entiat NFH program – undetermined stock (new program under development)	USFWS	Reclamation	Entiat
Entiat NFH steelhead kelt reconditioning (new program under development)*	Yakama Nation	BPA	Entiat
Winthrop NFH Methow Composite spring Chinook	USFWS	Reclamation	Methow
Winthrop NFH steelhead	USFWS	Reclamation	Methow
Methow/Okanogan coho	Yakama Nation	BPA	Methow
Wenatchee coho	Yakama Nation	BPA	Wenatchee

** At this time, it is uncertain where the Yakama Nation kelt reconditioning program will be located. Entiat NFH is a potential site. The Yakama Nation would be the operator, with funding from BPA, for this FCRPS BiOp/Columbia Basin Fish Accords project.*

RPA Action 40 – Reform FCRPS Hatchery Operations to Reduce Genetic and Ecological Effects on ESA-listed Salmon and Steelhead*: The Action Agencies will undertake/fund reforms to ensure that hatchery programs funded by the Action Agencies as mitigation for the FCRPS are not impeding recovery. The Action Agencies will work with FCRPS mitigation hatchery operators to cost effectively address needed reforms of current hatchery programs while continuing to meet mitigation responsibilities. Specific reforms to be implemented under this action (following any necessary regulatory approval) are listed in Table 6 of the RPA action table. Other reforms will be identified and implemented following the conclusion of the Columbia River Hatchery Scientific Review Group process.*

1. *For Lower Columbia Chinook: The COE will review the John Day Hatchery Mitigation Program.*

   Review of the John Day Mitigation Program will have to take into account the requirements of *U.S. v. Oregon.* In late 2008 the Corps learned that the *U.S. v. Oregon* parties believed the magnitude and makeup (upriver brights v. tules) of hatchery releases in the John Day Mitigation Program should be adjusted. However, the Corps did not receive a written statement of and justification for

that position until 2009. Therefore, 2008 action on program review was limited to a review of the historical basis for the existing program. (Discussions and review are continuing in 2009.) However, in 2008 the Corps did finalize the plan for reprogramming production of juveniles and transferring releases between Spring Creek National Fish Hatchery (above Bonneville Dam) and Bonneville Hatchery (below Bonneville Dam).

The Corps coordinated with the *U.S. v. Oregon* parties regarding development of their position on, and justification for, the changes they believe necessary in the John Day Mitigation Program. In addition, the Corps reprogrammed production between Spring Creek NFH and Bonneville Hatchery.

2. *For Snake River Steelhead: Fund the Tucannon River steelhead supplementation program to transition to local broodstock using BMPs.*

This action will be funded by BPA and implemented by the Lower Snake River Compensation Plan (LSRCP) program office and the Washington Department of Fish and Wildlife (WDFW), the LSRCP hatchery program operator for the Tucannon River steelhead supplementation program. In 2008, BPA staff began preliminary implementation planning with USFWS LSRCP staff. Implementation will require considerable coordination among USFWS and co-managers, and some feasibility issues have been identified that will need to be explored further in 2009.

3. *For Middle Columbia Steelhead: Fund the Touchet River steelhead supplementation program to transition to local broodstock using BMPs.*

This action will be funded by BPA and implemented by the LSRCP program office and WDFW, the LSRCP hatchery program operator for the Touchet River steelhead supplementation program. In 2008, BPA staff began preliminary implementation planning with USFWS LSRCP staff. Implementation will require coordination among USFWS and co-managers, and some feasibility issues have been identified that will need to be explored further in 2009.

4. *For Upper Columbia Steelhead: For the Winthrop NFH steelhead program, implement measures to transition to local broodstock and to manage the number of Winthrop NFH-produced steelhead on the spawning grounds. Such broodstock and adult escapement reform measures, including capital construction, would be identified through development of an updated HGMP and ESA consultation. Implementation of reform measures is contingent on a finding, in consultation with NOAA, that the measures are biologically and economically feasible and effective. Implementation of reforms will be prioritized and sequenced.*

The Winthrop National Fish Hatchery initiated a pilot program to evaluate longer-term (2-year) rearing of juvenile steelhead as part of a program to transition to a locally adapted steelhead broodstock in the Methow River. The pilot program, which will continue for several more years, involves rearing 25,000 juvenile steelhead for release in spring 2010. There was discussion about where on the Methow River and how to manage returning adult steelhead on the spawning grounds. One option is to intercept adult steelhead at Foghorn Dam. The fish ladder at Foghorn Dam has not been tested, and there are plans to test it for adult steelhead during the spring 2009 run. Foghorn Dam is not a complete barrier to fish passage, and it is relatively easy for adult fish to pass, so a weir or some other type of structure might be required to guide upstream migrating fish for collection.

BPA funded the Hatchery Scientific Review Group (HSRG) process in 2008 to enable the HSRG to complete its comprehensive review and analysis of all Columbia River Basin hatchery programs and its final report with recommendations for hatchery reform.

Hatchery Strategy 2 (RPA Actions 41–42)

RPA Action 41 – Implement Safety Net Programs to Preserve Genetic Resources and Reduce Short-term Extinction Risk*: The Action Agencies will continue to fund the operation of on-going "safety net" programs that are providing benefits to ESA-listed stocks at high risk of extinction by increasing genetic resources and will identify and plan for additional safety-net programs, as needed.*

1. *For Snake River sockeye: Continue to fund the safety net program to achieve the interim goal of annual releases of 150,000 smolts while also continuing to implement other release strategies in nursery lakes such as fry and parr releases, eyed-egg incubation boxes, and adult releases for volitional spawning (see Action 42 for expansion of the program for building genetic resources and assisting in promoting recovery).*

   BPA continued to fund the Snake River Sockeye Salmon Captive Broodstock Program (BPA Project 2007-402-00) to preserve this species. The program has produced hundreds of thousands of progeny from remnants of the wild stock. The progeny are raised in carefully managed hatcheries and released into their natural habitats using multiple release strategies, including smolt, fry, and parr releases; eyed-egg incubation boxes; and adult releases for volitional spawning. The Stanley Basin Technical Oversight Committee continues to provide guidance on the program. Since 1999, 1,005 adults from the program have returned to Redfish Lake. In 2008, 650 adult sockeye salmon returned to the Stanley Basin. This is the largest recorded annual return since 1956.

   On September 2, 2008, the new state-of-the-art fish hatchery building was dedicated at the Idaho Department of Fish and Game (IDFG) Eagle Fish hatchery. This is one of three related efforts to increase sockeye salmon smolt production to 150,000 sockeye salmon smolts — and an initial step toward a goal of producing 500,000 to 1 million sockeye salmon smolts. This expanded capacity will accommodate additional sockeye salmon broodstock holding, adult spawning, egg incubation, and juvenile rearing.

2. *For Snake River Spring/Summer Chinook: For the Tucannon River spring/summer Chinook safety-net supplementation program fund capital construction, operation and monitoring and evaluation costs to implement a program that builds genetic diversity using local broodstock and a sliding scale for managing the composition of natural spawners comprised of hatchery-origin fish.*

   In 2008, BPA continued to fund this safety-net program through BPA Project 2000-019-00, the Tucannon River Spring Chinook Captive Broodstock Program.

3. *For Snake River Spring/Summer Chinook: For the Upper Grande Ronde and Catherine Creek safety net supplementation programs fund capital construction, operation and monitoring and evaluation costs to implement a program that builds genetic diversity using local broodstock, and a sliding scale for managing the composition of natural spawners comprised of hatchery origin fish.*

   In 2008, BPA continued to fund this safety-net program through BPA Project 2007-404-00, Oregon Spring Chinook Captive Propagation.

4. *For Snake River Spring/Summer Chinook: Fund the Johnson Creek / South Fork Salmon River safety net supplementation program, as described in the existing Section 10 permit.*

   In 2008, BPA continued to fund this safety-net program through BPA Project 1996-043-00, the Johnson Creek Artificial Propagation Enhancement Project.

5. *For Snake River Spring/Summer Chinook: Fund the experimental captive rearing program for East Fork and West Fork Yankee Fork Salmon River (until phased out by IDFG).*

   In 2008, BPA continued to fund this experimental captive rearing program through BPA Project 2007-403-00, Idaho Snake River Spring Chinook Captive Propagation.

6. *For Snake River Steelhead, as a project to benefit primarily B-run steelhead, the Action Agencies will work with NOAA Fisheries to develop a trigger for future artificial propagation safety-net planning or to identify populations for immediate safety-net planning.*

   It is not feasible to implement this action at this time because of a lack of adequate B-run steelhead population viability data. Once sufficient data are available (as determined by NOAA) through the enhanced Snake River B-run steelhead population productivity and abundance monitoring called for in RPA Action 50.5, we will begin to work with NOAA to develop the type of "trigger" described above. We estimate it may be several years before adequate data are available from the enhanced monitoring effort

RPA Action 42 – Implement Conservation Programs to Build Genetic Resources and Assist in Promoting Recovery: The Action Agencies will implement conservation programs for ESA–listed stocks where the programs assist in recovery.

1. *For Upper Columbia Spring Chinook: Fund reintroduction of spring Chinook salmon into the Okanogan Basin consistent with the Upper Columbia Salmon Recovery Plan including capital construction, operation and monitoring and evaluation costs to implement a transition to local broodstock and a sliding scale for managing the composition of natural spawners composed of hatchery origin fish. Re-introduction will be coordinated with the restoration and improvement of spring Chinook habitat in the Okanogan Basin and will be contingent on the availability of within ESU broodstock from the Methow Basin.*

   When constructed and fully operational, the BPA-funded Chief Joseph Hatchery is expected to serve as the artificial production facility needed for this reintroduction program. As stated above, this production will initially be contingent on the availability of within-ESU spring Chinook broodstock from the Methow Basin. As of December 2008, the Confederated Colville Tribes' proposal for the Chief Joseph Hatchery was proceeding through the Council's Three-Step Review process for major artificial production projects. Chief Joseph Hatchery is expected to be approved in 2009 to move into review Step 3 (final design), and construction is anticipated to begin in 2010.

2. *For Upper Columbia Steelhead: Fund a program to recondition natural origin kelts for the Entiat, Methow and Okanogan basin, including capital construction, operation and monitoring and evaluation costs.*

   In 2008, the Yakama Tribes developed a proposal for upper Columbia River steelhead kelt reconditioning that would implement this RPA action as well as a similar Columbia River Fish Accords action. The proposal will be funded under the BPA project Upper Columbia River Kelt Reconditioning. As of December 2008, the proposal was undergoing scientific review and revision.

3. *For Upper Columbia Steelhead: Fund a program that builds genetic diversity using local broodstock and accelerates steelhead recovery in the Okanogan Basin as steelhead habitat is restored and improved, including capital construction, operation, and monitoring and evaluation costs.*

   This action is being implemented by the Confederated Colville Tribes through a Fish and Wildlife Program/Columbia River Fish Accords project: Local Okanogan Steelhead Broodstock.

4. *For Middle Columbia Steelhead: Fund a program to recondition natural origin kelts in the Yakima River basin including capital construction, implementation and monitoring and evaluation costs.*

   In 2008, BPA continued to fund this action through a BPA project, Kelt Reconditioning/ Reproductive Success.

5. *For Snake River Steelhead: For the East Fork Salmon River, fund a small-scale program (no more than 50,000 smolts) including trapping locally returning steelhead in the East Fork Salmon River for broodstock, and follow BMPs for rearing, release, and adult management strategies. Fund capital construction, operation, and monitoring and evaluation costs to implement a program that builds genetic diversity using local broodstock and a sliding scale for managing the composition of natural spawners comprised of hatchery origin fish.*

In 2008, BPA continued to fund operation and maintenance for this action through the LSRCP Direct Funding Agreement.

6. *For Snake River Spring/Summer Chinook Salmon: For the Lostine and Imnaha rivers, contingent on a NOAA approved HGMP, fund these hatchery programs including capital construction, operation and monitoring and evaluation costs to implement supplementation programs using local broodstock and following a sliding scale for managing the composition of natural spawners composed of hatchery origin fish.*

   As of December 2008, NOAA had not approved an HGMP for this action. Because funding of the action is contingent on a NOAA-approved HGMP, BPA did not fund construction of the Northeast Oregon Hatchery Lostine and Imnaha spring/summer Chinook propagation facilities in 2008. It could be that the earliest date for NOAA approval of an HGMP will be during the RPA Action 39 ESA consultation process for the Snake River Basin, which is scheduled to start in February 2010 and conclude in August 2010.

7. *For Snake River Sockeye: Fund further expansion of the sockeye program to increase total smolt releases to between 500,000 and 1 million fish.*

   On September 2, 2008, BPA signed a Fish Accord with Idaho that will provide funding certainty over a 10-year period. The accord included the commitment to provide funding for a new sockeye salmon fish hatchery (property acquisition and construction). Throughout 2008, BPA worked with IDFG to identify and begin the acquisition process for property meeting the criteria for a facility that will assure propagation of up to 1 million sockeye salmon smolts. Funding will be provided through ongoing BPA projects.

8. *For Snake River Sockeye: The Action Agencies will work with appropriate parties to investigate feasibility and potentially develop a plan for ground transport of adult sockeye from LGR Dam to Sawtooth Valley lakes or artificial propagation facilities.*

   Development of the study plan to investigate the feasibility of transporting adult sockeye began in 2009.

9. *For Columbia River Chum: Fund a hatchery program to re-introduce chum salmon in Duncan Creek including capital construction, implementation and monitoring and evaluation costs as long as NOAA Fisheries considers it beneficial to recovery and necessary to reduce extinction risk of the target population.*

   In 2008, BPA continued to fund this action through the BPA project Reintroduction of Chum Salmon into Duncan Creek.

10. *For Columbia River Chum: Fund assessment of habitat potential, development of reintroduction strategies, and implementation of pilot supplementation projects in selected Lower Columbia River tributaries below Bonneville Dam.*

    As of December 2008, WDFW was developing a proposal for a BPA-funded project to implement this action.

Predation Management Implementation Reports, RPA Action 43–49

Table 6. Predation Management RPA Action Requirements

RPA No.	Action	Annual Report Requirement
Predation Management Strategy 1		
43	Northern Pikeminnow Management Program (NPMP)	Annual progress reports will describe actions taken, including: • Number of pikeminnow removals • Estimated reduction of juvenile salmon consumed • Average exploitation rate Results of periodic program evaluations (including updates on age restructuring and compensatory responses)
44	Develop strategies to reduce non-indigenous fish	Beginning in 2010, annual progress reports will describe actions taken as a result of the workshop.
Predation Management Strategy 2		
45	Caspian Tern	Annual progress reports will describe actions taken toward the implementation of the Caspian Tern Management Plan.
46	Double-Crested Cormorant	Annual progress reports will describe actions taken if warranted.
47	Inland Avian Predation	Annual progress reports will describe actions taken if warranted.
48	Other Avian Deterrent Actions	Annual deterrent actions will not be reported.
Predation Management Strategy 3		
49	Marine Mammal Control Measures	Not applicable.

Predation Management Strategy 1 (RPA Actions 43–44)

RPA Action 43 – Northern Pikeminnow Management Program*: Action Agencies will continue to annually implement the base program and continue the general increase in the reward structure in the northern pikeminnow sport-reward fishery consistent with the increase starting in 2004. To better evaluate the effects of the NPMP, BPA will increase the number of tagged fish. The Action Agencies will evaluate the effectiveness of focused removals of pikeminnow at The Dalles and John Day dams and implement as warranted. Additional scoping of other mainstem dams will be based upon evaluations and adaptive management principles with input from NOAA Fisheries, and other regional fisheries managers.*

Since 1990, BPA has funded the Northern Pikeminnow Management Program (NPMP) to reduce the numbers of larger pikeminnow and improve survival of juvenile salmon. In 2004, after BPA increased the reward for the catch of this predator, the number of pikeminnow removed increased by 25 percent compared to prior years. The increased reward was made permanent in 2005 to sustain the higher catches. This resulted in the highest harvest rate of pikeminnow observed since the program began. The pikeminnow program has removed more than 3.3 million northern pikeminnow from the Columbia River since 1990. Evaluation indicates that as a result of the program, pikeminnow predation on juvenile salmon has declined 38 percent, saving 5 million juvenile salmon annually that would otherwise have been eaten by this predator.

The 2008 BiOp calls for BPA to increase tagging efforts to boost the number of tagged northern pikeminnow to better inform and increase the statistical significance of the biological evaluation of pikeminnow removals. The evaluation component of the NPMP uses tag recoveries in sponsored fisheries to quantitatively measure the benefit of removals within the year and cumulatively. In 2008, researchers were able to increase cumulative tagging efforts, which resulted in increases in year-over-year application of tags by 75 percent. The biggest gain was in the Snake River system, most notably Lower Granite and Little Goose pools, which increased the number of marks by more than 400 percent compared to 2007. This increase in tagging and resultant improvement in estimation is consistent with the 2008 BiOp and Independent Scientific Advisory Board (ISAB) recommendations (The Northern Pikeminnow Management Program Justification, Performance, and Cost Effectiveness, Hankin, 2001 *http://www.nwcouncil.org/library/2000/2000-16.pdf*). Also in 2008, the exploitation rate on northern pikeminnow was 19.5 percent, which continues to be at the high end of program objectives based on the hypothesis that a 10 to 20 percent exploitation rate (on northern pikeminnow 9 inches or longer) could achieve up to a 50 percent reduction in predation mortality (Rieman and Beamesderfer 1990). The exploitation rate was based on a numerical catch of 163,640 from a sport reward fishery and dam angling fishery. As part of the ongoing annual evaluation of the NPMP, managers determined that continued implementation of the dam angling program component is warranted based on 2008 catches.

RPA Action 44 – Develop strategies to reduce non-indigenous fish*: The Action Agencies will work with NOAA Fisheries, states and tribes to coordinate to review, evaluate, and develop strategies to reduce non-indigenous piscivorous predation. The formation of a workshop will be an initial step in the process.*

In September 2008, BPA sponsored a one-day workshop entitled "Review, Evaluate, and Develop Strategies to Reduce Non-Native Piscivorous Predation on Juvenile Salmonids." More than 100 people attended, representing states, tribes, federal fish management agencies, Action Agencies and other stakeholders. Results of the facilitated workshop and follow-up topics were compiled and presented to NOAA. Next steps in the development of strategies to reduce non-indigenous fish are to narrow the dozen or so grouped recommendations to two or three through continued collaboration with the regional agencies and tribes. Once the topic areas have been narrowed, basic or applied research can occur by implementing actions to address the focal areas of concern.

Predation Management Strategy 2 (RPA Action 45–48)

RPA Action 45 – Reduce Caspian Terns on East Sand Island in the Columbia River Estuary*: The FCRPS Action Agencies will implement the Caspian Tern Management Plan. East Sand Island tern habitat will be reduced from 6.5 to 1.5 to 2 acres. It is predicted that the target acreage on East Sand Island will be achieved in approximately 2010.*

In addition to the monitoring conducted at East Sand Island, in 2008 the Corps began implementing the *Caspian Tern Management to Reduce Predation of Juvenile Salmonids in the Columbia River Estuary* plan. The EIS for the plan was published in January 2005 (*https://www.nwp.usace.army.mil/pm/e/en_plan_avian.asp*). The plan, jointly prepared by USFWS (lead), Corps, and NOAA Fisheries, was developed to further reduce Caspian tern predation on juvenile salmon. The preferred alternative in the EIS recommends that available tern nesting habitat on East Sand Island be reduced to 1 to 1.5 acres (from 6 acres) to redistribute approximately two-thirds of the Caspian terns (2,500 to 3,125 breeding pairs). Reduction of East Sand Island habitat cannot occur until Caspian tern habitat is created or improved on alternate sites, mainly in Oregon and California. Two acres of alternative habitat must be created for every acre of habitat reduced on East Sand Island. The USFWS and the Corps signed separate records of decision (RODs) adopting the plan (a modified preferred alternative that excluded the Dungeness, Washington, alternative habitat site) in November 2006. NMFS completed the biological opinion for the proposed action on February 16, 2006.

In 2008, the Corps began implementing the Caspian Tern Management Plan with construction of an island in Fern Ridge Reservoir (Oregon). The 1-acre square island, created from sand and rock, was completed in February. The Corps, in conjunction with OSU researchers, deployed tern decoys and tern colony sounds in order to attract terns to nest on the island as they returned to the Northwest in the spring 2008. Unfortunately, though, these attraction efforts were unsuccessful – no terns nested on the island in 2008. At the end of the breeding season, there were a small number of terns using the island. Those birds may return to the island in 2009 to breed.

While terns have been slow to respond to the newly created island at Fern Ridge Reservoir, the opposite has been true of the other island created in 2008, which was constructed in Crump Lake (Oregon). Construction of the Crump Lake Island was completed in March of 2008. The island also covers 1 acre, but unlike the Fern Ridge island, it is elliptical and built on top of a remnant island. Caspian terns arrived on the island in early May, very soon after construction was completed. Approximately 428 breeding pairs of terns nested on the Crump Lake Island in 2008. In addition to terns, the island attracted breeding ring-billed gulls, California gulls, and double-crested cormorants. American white pelicans also used the island. The Caspian terns' diet primarily included Tui chub, catfish, crappie, and bass. The terns consumed a small number of Warner suckers, which is a listed species. The Corps is currently consulting with USFWS to determine an acceptable level of take.

Finally, the first of three islands was constructed in Oregon's Summer Lake State Wildlife Area. The round half-acre island was built in the East Link Unit. Construction was completed in December 2008. (Social attraction, tern decoys, and tern colony sounds were used in spring 2009 to attract terns to the island. Note that these social attraction cues are being employed at all of the islands constructed or enhanced through the tern management plan.)

Construction of the remaining Summer Lake sites and of the planned California sites is as follows:

- Dutchy Lake half-acre (floating island), February 2009
- Gold Dike half-acre rock island, July/August 2009
- Tule Lake (Klamath Basin), July/August 2009
- Orem Unit (Klamath Basin), September 2009
- Sheepy Lake (Klamath Basin), October/November 2009
- Hayward Regional Shoreline (SF Bay), November 2009

(The second Summer Lake Island—Dutchy Lake—was successfully constructed early in 2009, increasing the total to 3 acres of habitat constructed prior to the 2009 Caspian tern breeding season. This allowed the Corps to reduce the available tern nesting habitat on East Sand Island from 5 acres to 3.5 acres prior to the 2009 breeding season. This reduction was not expected to have a significant impact on terns nesting on East Sand Island because, in 2007 and 2008, the colony on East Sand used only approximately 3.6 acres of the available habitat. Note that, because of the limited colony area, the available habitat was reduced by 1 acre prior to the 2008 breeding season.)

RPA Action 46 – Double-Crested Cormorants*: The FCRPS Action Agencies will develop a cormorant management plan encompassing additional research, development of a conceptual management plan, and implementation of warranted actions in the estuary.*

The double-crested cormorant colony on East Sand Island consisted of about 10,950 breeding pairs in 2008, which represents a 20 percent decline in colony size compared to the previous year (about 13,770 pairs). Since monitoring began in 1997, the size of the cormorant colony has increased by about 120 percent. Nesting success in 2008 (2.26 fledglings per breeding pair) was down slightly from

2007 (2.78 fledglings per breeding pair). As in previous years, salmon made up a small portion (11 percent) of the cormorant diet in 2008, while marine forage fish (i.e., northern anchovy) and estuarine resident fish (i.e., sculpin, flounder, minnows) made up more than 40 percent of the diet.

Despite the lower reliance on salmon as a food source by cormorants compared to terns, total smolt consumption by cormorants was similar to or greater than that by terns. This is because double-crested cormorants are about four times larger than Caspian terns, the cormorant colony produces more young than the tern colony, and until this year, the cormorant colony was 40 percent larger than the tern colony. In 2007, cormorants nesting on East Sand Island consumed an estimated 9.2 million juvenile salmon (95 percent confidence interval = 4.4 to 14.0 million), compared to an estimated 6.7 million juvenile salmon (95 percent confidence interval = 5.8 to 7.5 million) consumed by terns nesting on East Sand Island. (Estimates of cormorant consumption of salmon smolts in 2008 are pending further analyses.)

An analysis of salmon PIT tags detected at the double-crested cormorant colony on East Sand Island indicated that all species of anadromous salmon (Chinook salmon, coho salmon, sockeye salmon, steelhead, and even sea-run cutthroat trout) from all run types (fall, winter, summer and spring) from all tagged ESUs were susceptible to cormorant predation in 2008. The numbers of PIT tags from the various salmon species and run types recovered on the cormorant colony were roughly proportional to the relative availability of PIT-tagged salmon released in the basin, suggesting that cormorant predation on salmon smolts in the estuary was less selective than tern predation. In contrast, PIT-tag recoveries on the East Sand Island tern colony indicated that steelhead were far more vulnerable to Caspian tern predation as compared to other salmon species. An analysis of salmon predation rates, based on the proportion of available PIT-tagged fish deposited on the cormorant colony, indicated that both hatchery and wild smolts were consumed, with rates averaging between 2 and 7 percent for most species and run types of PIT-tagged fish originating upstream of Bonneville Dam. However, predation rates in excess of 10 percent and 30 percent were observed for some groups of hatchery fall Chinook and hatchery coho salmon released downstream of Bonneville Dam. Unfortunately, data on wild migrants originating from downstream of Bonneville Dam are lacking and were not considered in this analysis.

A comparison of per-capita consumption rates of PIT-tagged fish between terns and cormorants nesting on East Sand Island suggests similar levels of take per nesting adult per colony, with an estimate of 2.1 and 1.7 PIT-tagged fish consumed per nesting tern and cormorant, respectively. Given the colonies were approximately the same size in 2008 (10,700 tern pairs and 10,950 cormorant pairs), per-capita PIT-tag consumption estimates suggest that smolt impacts were similar among these two colonies in 2008.

If the cormorant breeding colony on East Sand Island continues to expand and/or the proportion of salmon in cormorant diets increases, cormorant predation rates on juvenile salmon may far exceed those of Caspian terns nesting in the estuary. The discrepancy in predation rates for the two colonies will be even greater if the Caspian tern colony is reduced in size by more than 50 percent by 2015, as intended under the management plan now being implemented. Resource management agencies have not decided whether management of the large and expanding colony of double-crested cormorants on East Sand Island is warranted. Elsewhere in North America, management of double-crested cormorants has consisted primarily of lethal control (i.e., shooting of adults, oiling of eggs, and destruction of nests in trees). Non-lethal management approaches, such as relocating a portion of the colony to alternative colony sites along the coast of Oregon and Washington, seem more appropriate in the context of the cormorant colony on East Sand Island, which constitutes nearly 50 percent of the entire breeding population of the Pacific Coast subspecies *P. auritus albociliatus*.

In 2008, the Action Agencies continued a study to test the feasibility of potential management techniques for reducing losses of juvenile salmon to cormorant predation in the Columbia River estuary. This study sought to determine whether habitat enhancement and social attraction techniques can be used to induce double-crested cormorants to nest in an area outside the Columbia River estuary where they have not previously nested and, if so, whether these techniques can be used to redistribute some of the double-crested cormorants nesting in the Columbia River estuary to alternative colony sites outside the estuary, if deemed necessary by the resource management agencies. In 2008, the Action Agencies continued to employ habitat enhancement (i.e., placement of old tires filled with nesting material) and social attraction techniques (i.e., decoys and audio playback systems; Kress 2000 and 2002 and Roby et al. 2002) on a floating platform in Fern Ridge Reservoir, near Eugene, Oregon. Fern Ridge Wildlife Area was selected because it supported significant numbers of cormorants during the non-breeding season.

Cormorants did not attempt to nest on the floating platform and were never observed perched on the floating platform during the nesting season in 2008, although small numbers of double-crested cormorants were observed at Fisher Butte. Developing methodologies to enhance the size of existing double-crested cormorant colonies, along with establishing new colonies using habitat enhancement and social attraction techniques, may be necessary to shift cormorants from the large and growing colony on East Sand Island to alternative colony sites where ESA-listed salmon are not as vulnerable to cormorant predation.

In 2008, the Action Agencies investigated two techniques to discourage nesting by double-crested cormorants on East Sand Island. The first technique, human disturbance, was used on a discrete portion of the breeding colony area. The second technique, hazing with a green laser, was used on cormorants that were roosting on beaches adjacent the colony.

Isolated human disturbance was tested as a potential method to discourage double-crested cormorant nesting on East Sand Island. Prior to the initiation of any breeding, a visual barrier (a fence of black plastic fabric about 1.5 meter tall) was erected to isolate a small section of the eastern end of the cormorant colony. Disturbances ceased once there was evidence of egg laying.

In addition to human disturbance, a green laser (LEM50 laser torch) was used to test its efficacy in dispersing targeted double-crested cormorants from roosting locations on the island. The laser was used in the first week of May, after the cormorants had initiated egg laying; therefore, its application was restricted to roosting individuals and flocks that were encountered off-colony. Lasers were not used to cause nest abandonment. Technicians attempted to haze birds daily, varying the time of day and range to target birds and employing the laser under different weather and light conditions. They recorded the response of targeted individuals and flocks. Tests that resulted in flushing response for some or all of the target birds were considered successful.

Both disturbance measures tested were effective at flushing birds, but each was initiated too late in the breeding cycle to adequately determine its effectiveness to deter egg laying. The effects of human disturbance likely were limited because birds had already established a moderate to high level of commitment to nesting territories and pair bonds. Short-duration human disturbances (less than 5 minutes) were not effective at keeping cormorants off the colony for periods that were likely to inhibit nest initiation. However, short disturbances might have been effective if initiated earlier in the breeding cycle.

RPA Action 47 – Inland Avian Predation*: The FCRPS Action Agencies will develop an avian management plan (for Double-Crested Cormorants, Caspian Terns, and other avian species as determined by RME) for Corps-owned lands and associated shallow water habitat.*

The action agencies in 2008 continued to monitor avian predator populations in the Mid-Columbia River and evaluate their impacts on outmigrating juvenile salmon. Research efforts focused on determining whether management of the Crescent Island Caspian tern and Foundation Island double-crested cormorant colonies is warranted and to determine whether potential management techniques would reduce total consumption of fish. Actions in 2008 included determining the diet composition and consumption of juvenile salmon and the effects of operational strategies on avian predation rates on juvenile salmon.

In 2008, approximately 388 pairs of Caspian terns nested on Crescent Island, continuing a downward trend in colony size that began in 2001. Caspian terns also nested at a new colony site on Rock Island in the John Day Pool. This colony included about 100 pairs but only fledged three chicks. The double-crested cormorant colony on Foundation Island increased to approximately 360 pairs in 2008 compared to 2007, when about 330 pairs of cormorants nested on the island.

As in past years, avian predation on Snake River steelhead in 2008 was greater than on other salmon species. Steelhead made up an estimated 19 percent of identifiable salmon smolts consumed by Crescent Island Caspian terns. Similar predation levels occurred on steelhead by Foundation Island cormorants in 2008. Research related to Crescent Island Caspian tern and Foundation Island double-crested cormorant colonies is scheduled to be completed in 2009.

A pilot study was initiated in 2007 to determine how Snake River steelhead smolt morphology, condition, and origin might relate to differences in smolt vulnerability. This study was expanded in 2008 to include Columbia River steelhead and to provide total consumption and predation rates.

A pilot study was also initiated in 2007 to determine whether overwintering cormorants on the Snake River prey on hold-over fall Chinook salmon. The study continued in 2008. Preliminary data suggest some predation on overwintering fall Chinook salmon in the Snake River.

In 2008 the Action Agencies and the USFWS met to begin discussing development of an avian management plan for Corps-owned lands. The development and implementation of avian management plan(s) will continue in collaborative discussions with the USFWS in 2009. The main objective of the Corps-owned lands management plan is to improve ESA-listed anadromous fish survival for fish rearing and migrating through the lower Snake and Columbia rivers.

RPA Action 48 – Other Avian Deterrent Actions*: The Corps will continue to implement and improve avian deterrent programs at all lower Snake and Columbia River dams. This program will be coordinated through the Fish Passage Operations and Maintenance Team and included in the FPP.*

Other avian deterrent actions, such as hazing and wire arrays, were carried out in accordance with the FPP (*http://www.nwd-wc.usace.army.mil/tmt/documents/fpp*) as called for in RPA Action 48.

Predation Management Strategy 3 (RPA Action 49)

RPA Action 49 – Marine Mammal Control Measures*: The Corps will install and improve as needed sea lion excluder gates at all main adult fish ladder entrances at Bonneville dam annually. In addition, the Corps will continue to support land and water based harassment efforts by NOAA Fisheries, Oregon Department of Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), and the Tribes to keep sea lions away from the area immediately downstream of Bonneville Dam.*

In 2008, the Corps implemented and evaluated a variety of sea lion deterrents, from physical barriers to non-lethal harassment. Sea lion exclusion devices (SLEDs) were installed at Bonneville Dam's 12 primary fishway entrances to prevent sea lions from entering the fishways; SLEDs were installed in

early 2008 and removed in June 2008. The SLEDs feature 15.38-inch (39.05-centimeter) gaps that are designed to allow fish passage. Floating orifice gates (FOGs) were equipped with stab plates to prevent sea lions from entering the fishway collection channel at the second powerhouse (PH2). In addition to these stab plates, SLED-like FOG barriers were installed at the two FOGs at the north and two FOGs at the south ends of the powerhouse in March 2008. Acoustic deterrent devices, which emit a 205-decibel sound in the 15 kHz range, were installed at fishway entrances in January 2008 and removed in May 2008.

Since 2006, the Corps has contracted with the U.S. Department of Agriculture (USDA) Wildlife Services to harass sea lions away from fishways and other dam structures. Dam-based harassment by USDA agents began in March 2008 and was conducted daily through the end of May 2008. Harassment involved a combination of acoustic, visual, and tactile non-lethal deterrents, including above-water pyrotechnics (cracker shells, screamer shells, or rockets), rubber bullets, rubber buckshot and beanbags.

In part supported by BPA, CRITFC conducted boat-based harassment along with ODFW and WDFW from December 11, 2007, through May 15, 2008. Boats operated from the Bonneville Dam tailrace (RM 146) downstream to navigation marker 85 (RM 139). The Corps granted boats access to the Boat Restricted Zone (BRZ), but given concerns about human and fish safety, harassment was not allowed within 30 meters of dam structures or within 50 meters of fishway entrances. The use of "seal bomb" deterrents was prohibited within 100 meters of fishways, collection channels, or fish outfalls for the second powerhouse corner collector and smolt monitoring facility. Boat crews ceased using seal bombs after adult salmon passage exceeded 1,000 fish per day. Corps biologists coordinated with USDA agents and boat-based crews from ODFW, WDFW, and CRITFC on all sea lion harassment activities at Bonneville Dam to ensure safety and increase the effectiveness of harassment efforts.

In 2006, Oregon, Washington, and Idaho applied to NOAA Fisheries for authorization under Section 120 of the Marine Mammal Protection Act (MMPA) to lethally remove or permanently relocate nuisance sea lions below Bonneville Dam. NOAA Fisheries created a Pinniped-Fishery Interaction Task Force to address this request, and the task force released its report in favor of the states' request in late 2007. In early 2008, NOAA Fisheries announced its approval of the three states' request for authority to remove these California sea lions. This decision was challenged in U.S. District Court, and the states were unable to lethally remove California sea lions in 2008.

Also supported in part by BPA, personnel from ODFW and WDFW operated four floating sea lion traps along the PH2 corner collector from March through May 2008. In accordance with their MMPA Section 120 authority, in 2008 ODFW and WDFW either transferred captured animals to holding facilities or released captured animals. Captured California sea lions that did not meet removal criteria were either tagged and released onsite or transported to Astoria for processing. Corps biologists assisted with the individual identification of captured sea lions and provided information used to determine whether individual California sea lions met removal criteria. The Corps also provided a Bonneville Dam project crane and rigging crew to ensure safe and secure trapping operations.

RME Implementation Reports, RPA Action 50–73

The following section provides information on the Research, Monitoring and Evaluation (RME) actions implemented by the Action Agencies in 2008. In many cases, Action Agency projects identify actions that were funded and initiated prior to the completion of the 2008 BiOp, or were initiated as part of a previous BiOp. This section of the report will highlight examples of how projects contracted in 2008 fulfilled the RPAs, while Section 4 provides the full list of projects.

Table 7. RME Strategy Requirements

RPA No.	Action	Annual Report Requirement
RME Strategy 1		
50	Fish Population Status Monitoring	Status of project implementation (including project milestones) through December of the previous year for all actions identified in Attachment B.2.6-1 or subsequent implementation plans.
51	Collaboration Regarding Fish Population Status Monitoring	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
RME Strategy 2		
52	Monitor and Evaluate Fish Performance within the FCRPS	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
53	Monitor and Evaluate Migration Characteristics and River Condition	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
54	Monitor and Evaluate Effects of Configuration and Operation Actions	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
55	Investigate Hydro Critical Uncertainties and Investigate New Technologies	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
RME Strategy 3		
56	Monitor and Evaluate Tributary Habitat Conditions and Limiting Factors	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
57	Evaluate the Effectiveness of Tributary Habitat Actions	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
RME Strategy 4		
58	Monitor and Evaluate Fish Performance in the Estuary and Plume	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
59	Monitor and Evaluate Migration Characteristics and Estuary/Ocean Conditions	• Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans. • Tabulate the amount of absolute acreage by habitat type that is restored or protected every year. (Initiate in FY 2007-2009 Projects.) • Report annually on indices of productivity for the estuary and ocean (i.e., Pacific Decadal Oscillation, primary productivity indices).

Table 7. RME Strategy Requirements

RPA No.	Action	Annual Report Requirement
60	Monitor and Evaluate Habitat Actions in the Estuary	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
61	Investigate Estuary/Ocean Critical Uncertainties	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
RME Strategy 5		
62	Fund Selected Harvest Investigations	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
RME Strategy 6		
63	Monitor Hatchery Effectiveness	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
64	Investigate Hatchery Critical Uncertainties	Status of project implementation (including project milestones) through December of previous year for all actions identified in implementation plans.
65	Investigate Hatchery Critical Uncertainties	Status of project implementation (including project milestones) and analysis of new information through December of the previous year.
RME Strategy 7		
66	Monitor and Evaluate the Caspian Tern Population in the Columbia River Estuary	Status of project implementation (including project milestones) through December of the previous year for all actions (habitat actions are population response) identified in implementation plans.
67	Monitor and Evaluate the Double-Crested Cormorant Population in the Columbia River Estuary	Status of project implementation (including project milestones) through December of the previous year for all actions (habitat actions are population response) identified in implementation plans.
68	Monitor and Evaluate Inland Avian Predators	Status of project implementation (including project milestones) through December of the previous year for all actions (habitat actions are population response) identified in implementation plans.
69	Monitoring Related to Marine Mammal Predation	Status of project implementation (including project milestones) through December of the previous year for all actions (habitat actions are population response) identified in implementation plans.
70	Monitoring Related to Piscivorous (Fish) Predation	Status of project implementation (including project milestones) through December of the previous year for all actions identified in implementation plans.
RME Strategy 8		
71	Coordination	Status of coordination of RME projects through December of the previous year will be provided.

Table 7. RME Strategy Requirements

RPA No.	Action	Annual Report Requirement
72	Data Management	Status of data management projects through December of the previous year will be provided.
RME Strategy 9		
73	Implementation and Compliance Monitoring	The Action Agencies will use the project-level detail contained in the Action Agencies' Biological Assessments databases to track results and assess our progress in meeting programmatic-level performance targets. This performance tracking will be reported through annual progress reports and the 2013 and 2016 comprehensive reports.

RME Strategy 1 (RPA Actions 50–51)

A comprehensive list of all actions implemented by the Action Agencies for RPAs 50 and 51 is included in Section 4.

RPA Action 50 – Fish Population Status Monitoring*: The Action Agencies will enhance existing fish population status monitoring performed by fish management agencies through the specific actions listed below. In addition, ancillary population status and trend information is being obtained through several ongoing habitat and hatchery improvement projects.*

1. *Implement and maintain the Columbia River Basin passive integrated transponder (PIT)-Tag Information System. (Annually)*

   The Columbia Basin Pit-Tag Information (PTAGIS), BPA project number 1990-080-00, continued in 2008 and fully covers the needs of this subaction. The project supported research that requires the selection or diversion of specific PIT-tagged fish at any of the mainstem juvenile or adult fish facilities. PTAGIS provides coordination, set-up, operations, and maintenance for about a dozen NPCC Fish and Wildlife Program (FWP) or AFEP projects throughout the fish migration season. The existing database will be revised to include information from interrogation systems that are being installed in tributaries to measure population-scale abundance and survival.

2. *Monitor adult returns at mainstem hydroelectric dams using both visual counts and the PIT-tag detection system (see Hydrosystem section). (Annually)*

   In 2008 the Corps of Engineers again implemented its adult fish count program as laid out in the Fish Passage Plan. Results are available in the *2008 Annual Fish Passage Report: Columbia and Snake Rivers*, available at *http://www.nwp.usace.army.mil/op/fishdata/docs/20080afpr.pdf*.

   The Lower Granite Dam Adult Trap Operations project, BPA project number 2001-003-00, continued in 2008. This project continues daily operation of the Lower Granite Dam (LGR) adult trap to sample steelhead, spring/summer Chinook, and PIT-tagged fall Chinook (scales and length measurement) for run-reconstruction and transportation and life history studies. For example, fish with coded-wire-tags or PIT tags (if targeted) were diverted into the adult trap holding area for collection of timed samples (a percentage of all passing adults) for run reconstructions. Operation information was included in the adult trap annual report provided to BPA. This RPA is fully covered through BPA project 2001-003-00 and the Corps adult fish count program.

3. *Monitor juvenile fish migrations at mainstem hydroelectric dams using smolt monitoring and the PIT-tag detection system (see Hydrosystem section). (Annually)*

   BPA continued implementation of two projects (1987-127-00 and 1994-033-00) and initiated one new project in 2008 to address the RPA subaction's requirement to monitor smolts. For example, the Smolt Monitoring by Non-Federal Entities project (BPA project number 1994-033-00) collected species, condition, and external mark detail from all sampled fish; condition and length data from a subsample of the smolts; and all incidental species caught in the samples. This RPA will be expanded and fully addressed in 2010 with additional PIT tagging of juvenile fish guided by a Hydro tagging plan.

4. *Fund status and trend monitoring as a component of the pilot studies in the Wenatchee, Methow, and Entiat river basins in the Upper Columbia River, the Lemhi and South Fork Salmon river basins, and the John Day River Basin to further advance the methods and information needed for assessing the status of fish populations. (Initiate in FY 2007-2009 Project Funding, review and modify annually to ensure that these projects continue to provide a means of evaluating the effectiveness of tributary mitigation actions).*

   In 2008, 38 projects continued to be implemented and one was initiated to support ongoing pilot studies. For example, the Integrated Status and Effectiveness program projects (BPA project numbers 2003-010-00 and 2003-017-00) conducted monitoring to evaluate food web and life history responses to habitat change. The projects also conducted juvenile snorkel surveys in winter (30) and summer (42) sampling sites to evaluate population dynamics at restoration sites compared to unrestored sites. The John Day, Lemhi and South Fork salmon populations currently have sufficient status and trend monitoring, while the Wenatchee, Entiat, and Methow have some additional needs that will be addressed with BPA projects in 2009.

5. *Provide additional status monitoring to ensure a majority of Snake River B-Run steelhead populations are being monitored for population productivity and abundance. (Initiate by FY 2009, then annually)*

   Sixteen projects were continued and one was initiated in 2008 to assess B-run steelhead abundance and productivity. For example, the Idaho Monitoring and Evaluation Studies Project (BPA project number 1990-055-00) PIT-tagged juveniles in streams of the Middle Fork Salmon, South Fork Salmon, and Little Salmon rivers to estimate juvenile steelhead production and timing. The project also snorkeled streams to estimate juvenile densities in the Clearwater River and tributaries and collected DNA tissue samples in the Salmon River and Clearwater tributaries to genotype and analyze genetic tissues. The Action Agencies plan to use BPA placeholder funds in BPA project number 2008-748-00 to support additional monitoring projects identified in a regional collaboration effort with state and tribal entities.

6. *Review and modify existing Action Agencies' fish population status monitoring projects to improve their compliance with regional standards and protocols, and ensure they are prioritized and effectively focused on critical performance measures and populations. (Initiate in FY 2008, develop proposed modification in FY 2009, and implement modifications in FY 2010)*

   Regional fish population status monitoring standards and protocol documentation tools were advanced through PNAMP in 2008 under project 2004-002-00. The RME work groups were initiated in 2008 to start work on evaluations to ensure appropriate prioritization and coverage of performance measures.

7. *Fund marking of hatchery releases from Action Agencies funded facilities to enable monitoring of hatchery-origin fish in natural spawning areas and the assessment of status of wild populations. (Annually)*

   Twenty-seven BPA projects were continued and one was initiated in 2008 that supported hatchery marking monitoring and research. For example, the Okanogan Basin Monitoring and Evaluation Program (OBMEP) project (BPA project number 2003-022-00) collected data on the abundance of out-migrating juvenile summer steelhead and summer/fall Chinook smolts and installed and tested

the operation of a smolt trap in one location on the Okanogan River. The Grande Ronde Supplementation Operations and Maintenance (O&M) and Monitoring and Evaluation (M&E) on Lostine River project (BPA project number 1998-007-02) provided summary data in an annual report on the number of conventional and captive rearing program fish tagged, the average length (mm), weight (g), and condition factors (Fultons), with standard errors and minimum and maximum values observed for each attribute. BPA project number 2008-740-00 was initiated to support additional marking under BPA-funded hatchery programs. Additional work may occur in the future under this RPA.

8. *Report available information on population viability metrics in annual and comprehensive evaluation reports. (Initiate in FY 2008)*

All Action Agency population viability information was gathered and stored for future viability assessments. BPA identified placeholder project funds to support the synthesis of fish population data for annual and comprehensive reports, and the Action Agencies and NOAA Fisheries agreed to support a process where NOAA Fisheries would provide population viability information for future reports. Also, the RME Work Group recommended finalizing the NOAA viable salmonid population (VSP) data dictionary in coordination with Northwest Environmental Information Sharing Executive Forum (NWEIS) and PNAMP and integrate those results into Action Agency project requirements. Current information on population abundance is provided in earlier sections of this report.

RPA Action 51 – Collaboration Regarding Fish Population Status Monitoring

The Action Agencies will enhance existing fish populations status monitoring performed by fish management agencies through the following collaboration commitments:

1. *Support the coordination, data management, and annual synthesis of fish population metrics through Regional Data Repositories and reports (Annually)*

Eight projects were continued and one was initiated to fully support annual synthesis of fish population data for reports. For example, the StreamNet Library Project (BPA project number 2008-505-00) supported participation in planning, development, and/or coordination meetings with regional projects and programs under the Northwest Power and Conservation Council's Fish and Wildlife Program to help develop a regional data management framework, to establish data type and data service priorities, and to provide advice in the area of data management, as requested.

2. *Facilitate and participate in an ongoing collaboration process to develop a regional strategy for status and trend monitoring for key ESA fish populations (Initiate in FY 2008)*

In collaboration with NOAA Fisheries, the Action Agencies and the Northwest Power and Conservation Council (NPCC) implemented the FCRPS BiOp RME work groups. They developed a process to engage state and tribal fish managers in identifying existing status and trend monitoring, gaps in federal monitoring programs, a process to collaborate with non-federal entities in the future to support the annual and comprehensive BiOp reports, and viability and listing factor status assessments. The Action Agencies supported the ongoing PNAMP coordination process through funding of project 2004-002-00 and contracted and staff support in the PNAMP steering committee and fish population work group.

3. *Provide cost-shared funding support and staff participation in regional coordination forums such as the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) fish population monitoring workgroup and the Northwest Environmental Data Network to advance regional standards and coordination for more efficient and robust monitoring and information management. (Annually)*

Seven BPA projects were continued in 2008 to fully provide cost sharing for staff support in regional monitoring and evaluation coordination. For example, the Pacific Northwest Aquatic

Monitoring Partnership (PNAMP) Support Project, BPA project number 2004-002-00, facilitated coordination work at the program, subbasin, and regional level by providing personnel to serve as the lead staff, liaison, and point of contact for PNAMP. This project supports coordination of PNAMP efforts to integrate resource monitoring programs of state, federal, tribal, local, and private organizations in the Pacific Northwest. This project also facilitates the transfer of information within PNAMP and across relevant organizations to establish and maintain strong relationships between science and management, and to promote and facilitate communication among organizations and disciplines. In 2008, BPA also provided contract support for facilitation of the Northwest Environmental Data (NED) Network forum to advance coordinated data management strategies. In addition to internal Action Agency staff support, technical experts were funded for participation in PNAMP and NED work group products. Action Agency staff also were active in the formation of the Northwest Information Sharing Executive Forum, which pulled together executives from multiple entities across the Pacific Northwest to advance the common goal of more efficient and robust monitoring and information sharing.

RME Strategy 2 – Hydrosystem RME (RPA Actions 52–55)

A comprehensive list of all actions implemented by the Action Agencies for RPAs 52 through 55 is included in Section 4. All but two RPA subactions are met by projects that either currently or soon will be in place. RPA subactions 52.6 and 55.3 are expected to involve additional action.

RPA Action 52 Monitor and Evaluate Fish Performance within the FCRPS

1. *Monitor and evaluate salmonid dam survival rates for a subset of FCRPS projects.*

   The Action Agencies addressed this RPA's subaction through implementation of two projects that have successfully demonstrated that acquiring survival estimates is feasible using strategically located releases of smolts tagged with active tags (Juvenile Salmonid Acoustic Tags, or JSATs, in these applications). However, the preferred experimental design has not yet been selected. There are two options being considered, a single-dam format and a multi-dam format. The region is in the process of determining which experimental design is most appropriate. (In 2009, under the AFEP program a new multi-dam experimental design was developed [SPE-06-2] that could substantially reduce costs and provide statistically sound dam survival estimates). In the Snake River the single-dam method is moving forward under projects SPE-W-08 and SPE-W-05 and may soon be applied in dam survival standard tests.

2. *Monitor and evaluate juvenile salmonid in-river and system survival through the FCRPS, including estimates of differential post-Bonneville survival of transported fish relative to in-river fish (D-value) as needed.*

   Eight projects were continued that addressed this RPA's subaction. Tagged smolts entering and migrating through the FCRPS (Lower Granite through Bonneville Dam) were used in 2008 to estimate survival and have been produced annually since 1994. NOAA Fisheries conducts the analysis under BPA project 1993-029-00 using fish PIT-tagged under the Smolt Monitoring Program (BPA project number 1987-127-00) and Comparative Survival Study (CSS) (BPA project number 1996-020-00).

3. *Monitor and evaluate adult salmonid system survival upstream through the FCRPS.*

   Four projects were continued to fulfill this subaction. For example, the PTAGIS system, BPA project 1990-080-00, provides data on returning adults of known origin. In addition, NOAA biologists conducted analyses and reported upstream passage survival for 2008.

4. *Provide additional PIT-tag marking of Upper Columbia River populations to provide ESU specific estimates of juvenile and adult survival through the Federal mainstem dams.*

   One project was continued and one project's funds have been allocated to initiate and fully address this effort as early as 2009 (BPA project number 2008-724-00). Planning is ongoing for the extent of tagging and stock coverage required and will be specified in the tagging plan being developed under RPA Action 52.6. But the extent of tagging and stock coverage has not yet been specified. These populations would be incorporated into the annual system smolt and adult survival monitoring. Efforts being undertaken by public utility districts may supplement the federal effort.

5. *Assess the feasibility of PIT-tag marking of juvenile Snake River Sockeye Salmon for specific survival tracking of this ESU from the Stanley Basin to Lower Granite Dam and through the mainstem FCRPS projects.*

   One onging project (BPA project number 1987-127-00) was continued and two projects (BPA project number 2008-724-00 and 2008-735-00) were initiated to address this subaction. This work is a pilot study in 2009 to assess long-term needs with respect to precision levels and sample sizes for future work.

6. *Develop an action plan for conducting hydrosystem status monitoring (analytical approaches, tagging needs, methods, and protocols) in ongoing collaboration with the State and Federal fishery agencies and Tribes. This will be done in coordination with status monitoring needs and strategies being developed for estuary/ocean, habitat, hatcheries, and harvest. (Initiate in FY2009)*

   Two existing projects were continued to support the baseline monitoring needs of this RPA. This RPA action will be addressed in FY2009 and 2010 through development of a regional PIT-tagging plan, including input from the Action Agencies, NOAA, other federal agencies, and state and tribal agencies.

7. *Cooperate with NOAA Fisheries, US v Oregon parties, Confederated Tribes of the Colville Reservation, and other co-managers to 1) review relevant information and identify factors (migration timing, spatial distribution, etc.) that might explain the differential conversion rates (BON to MCN) observed for UCR steelhead and spring Chinook salmon compared to SR steelhead and spring/summer Chinook salmon (see RPA Table 7 and **SCA - Adult Survival Estimates Appendix); 2) develop a monitoring plan to determine the most likely cause of these differential losses (considering the potential use of flat plate PIT-tag detectors in tributaries or fishery areas, additional adult detectors at The Dalles and John Day fishways, etc. to provide improved estimates of harvest or stray rates for improved conversion rate estimates in the future); and 3) implement the monitoring plan.*

   The feasibility of using a tributary PIT antenna to detect adult salmon in the John Day River (see RPA Action 52) was evaluated. The PIT antenna withstood spring freshet flows and has been detecting PIT-tagged adult fish. (Effectiveness monitoring will be carried out in 2009 to determine the detection efficiency of the system.)

RPA Action 53 Monitor and Evaluate Migration Characteristics and River Condition

1. *Monitor and estimate the abundance of smolts passing index dams.*

   Four BPA projects were continued and one new one was initiated to address this subaction. For example, in 2008, the Fish Passage Center project (BPA project 1994-030-00) calculated passage indices at all collector dams, as well population estimates at Lower Granite Dam. NOAA seeks improved smolt abundance estimates and expanded coverage at more dam monitoring sites.

2. *Monitor and describe the migration timing of smolts at index dams, identify potential problems, and evaluate implemented solutions.*

   Nine BPA projects were continued and two new ones were initiated to fully address this subaction. For example, in 2008, this was addressed by the Smolt Monitoring Program, BPA project 1987-127-00. Data provided by this program were analyzed by the Fish Passage Center (BPA project number 1994-030-00) and NOAA Fisheries, as well as a host of other regional fish management

agencies. Additional evaluation of the Smolt Monitoring Program data is expected to determine the extent to which population-specific (PIT tagged) data are needed to describe timing.

3. *Monitor and document the condition (e.g., descaling and injury) of smolts at all dams with JBS systems, identify potential problems, and evaluate implemented solutions.*

Seven projects were continued to fully address this subaction. As in RPA Action 53.2, the Smolt Monitoring Program monitored and documented fish condition in 2008. The Fish Passage Center and other management agencies provided analysis and implementation recommendations. The reduction in handling was the only potential problem identified that may be addressed in future operations.

4. *Monitor and enumerate adult salmonids passing through fishways in the FCRPS, identify potential problems, and evaluate implemented solutions.*

In 2008 the Corps of Engineers again implemented its adult fish count program as laid out in the Fish Passage Plan. Results are available in the *2008 Annual Fish Passage Report: Columbia and Snake Rivers*, available at *http://www.nwp.usace.army.mil/op/fishdata/docs/2008afpr.pdf*

Fishways were monitored on a regular basis, as per Fish Passage Plan requirements. Results are discussed in an annual Fishway Inspection Report prepared for each project. Fishways were also inspected by representatives from NOAA Fisheries and other agencies. Results of those inspections are available at *http://www.fpc.org/documents/Fishway_Inspection_Reports.html*.

See also the discussion of adult passage improvements under RPA 28 above.

5. *In addition to current operations (generally April 10 – August 31), evaluate operation of the Bonneville PH2 corner collector from March 1 through start of spill as a potential means to provide a safer downstream passage route for steelhead kelts, and implement if warranted.*

A second year was completed for evaluating operation of the Bonneville PH2 corner collector from March 1 through start of spill as a potential means to provide a safer downstream passage route for steelhead kelts. The corner collector was estimated to have passed 107 steelhead kelts in 2007 and 223 in 2008 during this period. Discussions on future operation and evaluations are ongoing.

RPA Action 54 – Monitor and Evaluate Effects of Configuration and Operation Actions

1. *Monitor and evaluate the effects of existing spillways, modifications, and operations on smolt survival.*

In 2008, four Corps projects were continued to fully address this subaction. The effects of configuration and operation changes on juvenile fish passage were evaluated at John Day and Bonneville dams. Route-specific passage and survival rates were estimated at Lower Monumental, Ice Harbor, and McNary dams. Studies of passage conditions were conducted at the McNary and Lower Monumental spillway weirs and Ice Harbor spillway. See the entries for RPA Action 18 through 25 for specific studies and results.

2. *Monitor and evaluate the effectiveness of traditional juvenile bypass systems and modifications to such, on smolt survival and condition.*

Five projects were continued and one new project was initiated to fully address this subaction. AFEP regularly evaluates bypass performance as new systems are built, or upgrades occur to existing systems. The passage and survival studies above also estimated the proportions collected by the bypass system and the resulting survival rates.

3. *Monitor and evaluate the effectiveness of surface bypass structures and modifications on smolt survival and condition.*

Six projects were continued to support the estimated route-specific passage, and survival rates were estimated at John Day, Lower Monumental, Ice Harbor, and McNary dams to fully meet the

requirements of this subaction. (Copies of draft reports are under review and are available from the Corps.)

4. *Monitor and evaluate the effectiveness of turbine operations and modifications on smolt survival and condition.*

   There were no changes to monitor or evaluate in 2008.

5. *Monitor and evaluate overall dam passage with respect to modifications at projects (including forebay delay and survival).*

   Four Corps AFEP projects were continued to fully address this subaction through passage and survival studies, which estimate forebay and tailrace passage times and survival rates in the forebay.

6. *Monitor and evaluate the effectiveness of the juvenile fish transportation program and modifications to operations.*

   Eight projects were continued and one was initiated to fully address this subaction. In 2008, the Action Agencies continued to make progress on monitoring and evaluating the effectiveness of the juvenile fish transportation program. Information resulting from 2008 RME will enable further progress in identifying the benefits of transportation and supporting adaptive management actions. Significant 2008 RME is as follows:

   - **Spring Migrants:** The Action Agencies continued research to determine the potential of transportation to increase adult returns of anadromous salmon in 2008. A PIT tag study to evaluate weekly smolt-to-adult returns (SARs) for natural spring Chinook and steelhead transported from Lower Granite Dam continued in 2008. More precise transportation data in the April time frame should help clarify effects of transportation on early migrating fish. More precise data in the May time frame should allow for correlation of physical and environmental factors to guide Action Agencies on appropriate triggers of how to operate transportation on an annual basis to maximize adult returns.
   - **Summer Migrants:** In 2008, the Action Agencies continued implementing the 2007 fall Chinook salmon consensus transportation proposal and long-term framework developed collaboratively with regional fish management agencies and tribes. This intensive research, monitoring, and evaluation effort for subyearling fall Chinook salmon will help determine the appropriate management strategy to optimize adult returns.

     In 2008, intensive RME efforts were conducted on Snake River fall Chinook salmon. These efforts are expected to provide information to evaluate early life history and migration behavior, the performance of hatchery fish as surrogates for wild fish, and the benefits of late season transportation, as well as to compare production fish groups' performance to wild and surrogate fish.

7. *Monitor and evaluate the effects of environmental conditions affecting juvenile fish survival.*

   Six projects were continued to fully address this subaction. Total dissolved gas, temperature, turbidity, and flow are considered key factors, and they are regularly monitored throughout the FCRPS. Many PIT-tagged fish migrating through the system from assorted projects provide response units for analyzing effects on smolt survival or migration characteristics. The Fish Passage Center (FPC), NOAA, and the Comparative Survival Study (CSS) have conducted these types of probative analyses. The Corps funds the collection and recording of temperature and TDG data and index flow at dams. Data Access Real Time (DART) compiles and displays these and other environmental and fish data, as does the FPC.

8. *Monitor and evaluate the effectiveness of reducing predation toward improving juvenile fish survival.*

Nine projects were continued to fully address this subaction. In 2008, ongoing research under Columbia River Fish Mitigation (CRFM) and BPA Fish and Wildlife Program funding continued monitoring of avian predators and their colonies (O&M), dam angling, and estimates of annual exploitation of pikeminnow (modeling), in conjunction with juvenile dam survival studies.

9. *Investigate, evaluate and deploy alternative technologies and methodologies for fish passage and the RME Action.*

Eight projects were continued and one was initiated to address this subaction. New passage technologies have been and will continue to be prototyped, tested, and ultimately deployed as part of AFEP and CRFM. In 2008, two prototype TSWs were deployed at John Day Dam (see RPA 20 for details), and a new RSW was installed at Lower Monumental Dam (see RPA 23 for details).

10. *Determine if actions directed at benefiting juveniles have an unintended effect on migrating adults (e.g., certain spill operations).*

Six projects were continued to fully address this subaction. This issue is addressed at each project as need arises. The AFEP forum addresses this matter. As an example, in 2008, radio tags were used to determine whether spill patterns at Little Goose Dam were having a negative effect on adult passage (see RPA 28 for more detail).

11. *Install and maintain adult PIT-tag detectors in fish ladders at key dams in the FCRPS and evaluate adult survival (conversion rates).*

PIT-tag detectors are now installed in all key FCRPS ladders. However, currently there are no detectors at The Dalles and John Day dams. Tributary turn-off and straying between Bonneville and McNary dams is of concern when calculating conversion rates or upstream passage survival. If stream-based PIT detectors successfully function in the major tributaries in this reach, then the need for additional ladder coverage could be circumvented. (Those systems were tested in 2008 and will continue in 2009).

12. *Monitor and evaluate the effects of fish ladder operations and configurations on adult passage rates.*

Seven projects were continued and one was initiated to fully address this subaction. This issue is addressed at each project as needed through the AFEP process.

13. *In addition to the current sluiceway operation (generally April 1–November 30), evaluate operation of The Dalles Dam sluiceway from March 1–March 31 and from December–December 15 as a potential means to provide a safer fallback passage route for overwintering steelhead and kelts, implement if warranted.*

Two projects were continued to fully address the requirements of this subaction. From the winter of 2008 to the spring of 2009, an evaluation was conducted of operating The Dalles Dam sluiceway from March 1–March 31 and from December 1–December 15 as a potential means to provide a safer fallback passage route for overwintering steelhead and kelts.

14. *Investigate surface-flow outlets during wintertime to provide safer fallback opportunity for over wintering steelhead (need will be determined by results of further research).*

See RPA Action 54.13 above.

RPA Action 55 – Investigate Hydro Critical Uncertainties and Investigate New Technologies*: The Action Agencies will fund selected research directed at resolving critical uncertainties that are pivotal in lifecycle model analyses.*

1. *Investigate and quantify delayed differential effects (D-value) associated with the transportation of smolts in the FCRPS as needed. (Initiate in FY 2007–2009 Projects)*

Ten projects were continued and two were initiated to fully address this subaction. Species coverage is expected to expand in 2009 and beyond because sockeye and fall Chinook are

proposed for research. Other species will continue at some level, but the frequency of and sample size for acquiring estimates needs clarification for future years. This complements RPA 52.2, which calls for D-estimates to be incorporated into system survival evaluations. See discussion of RPA Action 31 for further details.

2. *Investigate the post-Bonneville mortality effect of changes in fish arrival timing and transportation to below Bonneville. (Initiate in FY 2007–2009)*

   Twelve projects were continued and two were initiated to fully address this subaction through review in AFEP, with focus on SARs from BON-BON. Recent NOAA transport studies treat this issue with the expectation that the regional PIT Tagging Plan will fully address the requirements of this RPA. See discussion of RPA Action 31 for further details.

3. *Conduct a workshop every other year with members of the Independent Scientific Advisory Board (ISAB) to review current research and monitoring approaches on post Bonneville mortality for transported and non-transported fish. (Initiate in FY 2009).*

   BPA and the Corps initiated a research project in 2008 to fully support this subaction. The workshop is in the early planning stages and is expected to be held in 2010. The workshop will synthesize research results and analyses, identify further needs, and plan the direction of future research.

4. *Investigate, describe and quantify key characteristics of the early life history of Snake River Fall Chinook Salmon in the mainstem Snake, Columbia, and Clearwater rivers. (Initiate in FY 2007-2009 Project).*

   Six projects were continued to fully address this subaction. Studies have been funded by BPA for more than a decade, and complementary projects (such as radio tag investigations in Snake reservoirs) have been funded by the Corps under AFEP. Additionally, proposed transport studies have important life history implications. This has been a complex, multi-faceted set of investigations that have taken place over years.

5. *Complete analysis and reporting of a multi-year (2000-2007) investigation on the effects of adult passage experience in the FCRPS on pre-spawning mortality (2008). Following reporting, SRWG will review the results and provide a recommendation on the need and nature of future research. Future research will be coordinated through the Regional Forum.*

   One project was continued and one was initiated to fully address this subaction. A multi-year research study has been conducted by the University of Idaho. Research was presented in draft form in 2008 and will be finalized in 2009.

6. *Continue development of state-of-the-art turbine units to obtain improved fish passage survival through turbines with the goal of using these new units in all future turbine rehabilitation or replacement programs.*

   One Corps project was continued to fully address this subaction. (The contract was advertised in spring 2009 and included design, manufacture, and delivery of a fixed blade for Unit 2 as a base contract item, with an option to manufacture and deliver an adjustable blade runner for Unit 3).

   In 2008, plans and specifications for a new Ice Harbor Dam turbine design and runner were completed. Turbine Survival Program activities related to this project that have been incorporated into the specifications include studies of the effects of pressure on fish traveling through the turbine. The Corps' observational model at its Engineer Research and Development Center (ERDC) has aided in narrowing the stay vane/wicket gate and draft tube modification alternatives to be considered during model testing under the contract.

7. *Investigate feasibility of developing PIT-tag detectors for spillways and turbines.*

   One project was continued and one was initiated to fully address this subaction. For example, BPA project number 1983-319-00 continued to address new detectors for spillways and turbines. Work

in 2008 involved determining the feasibility of installing a PIT detector in the spillway at Bonneville Dam, as well as the feasibility of installing detectors in the various surface spill weirs that are currently installed throughout the system.

8. *Evaluate new tagging technologies for use in improving the accuracy and assessing delayed or indirect hydro effects on juvenile or adult fish.*

Two projects were continued and one was initiated to fully address this subaction. JSATS (AFEP Program) and the Pacific Ocean Survival Tracking Project (POST) (BPA project number 2003-114-00) project both continued the development of tags and methods in 2008 to determine delayed or indirect effects of hydro passage by looking in the estuary below Bonneville Dam and the ocean environment off the Pacific Coast. Data from these efforts are presented in a variety of government reports and peer-reviewed journal articles.

9. *Assess the feasibility of developing PIT-tag detectors for use in natal streams and tributaries, or other locations, as appropriate to support more comprehensive and integrated All-H monitoring designs and assessments of stray rates.*

The feasibility of using a tributary PIT antenna to detect adult salmon in the John Day River was evaluated (see also RPA Action 52, Bullet 7). The PIT antenna withstood spring freshet flows and has been detecting PIT-tagged adult fish. (Effectiveness monitoring will be carried out in 2009 and 2010 to determine the detection efficiency of the system.)

The Corps supported efforts by NOAA Fisheries to develop a spillway PIT antenna design for Bonneville Dam. Dry tests were run on an existing spillway gate housed in the spillway repair pit. (Work in 2009 will include assessing vibration and electro-magnetic fields on an operating gate.)

Tagging Technologies: A comprehensive multi-year study to evaluate the short and long-term effects of acoustic tagging and tags was begun in 2007. The study was designed to compare behavior and survival of acoustic tagged fish to PIT-tagged fish as they migrate downstream through the Snake and Columbia rivers. In addition, in 2008, the 2007 objectives were repeated with a laboratory study designed to evaluate the effects of the tagging and acoustic tag processes on yearling and subyearling Chinook salmon. Results are pending.

RME Strategy 3 (RPA Actions 56–57)

A comprehensive list of all actions implemented by the Action Agencies for RPAs 56 and 57 is included in Section 4. For RPA 56 and 57, the RME Work Group identified additional monitoring to supplement this ongoing monitoring.

RPA Action 56 – Monitor and Evaluate Tributary Habitat Conditions and Limiting Factors: The Action Agencies will:

1. *Implement research in select areas of the pilot study basins (Wenatchee, Methow and Entiat river basins in the Upper Columbia River, the Lemhi and South Fork Salmon river basins, and the John Day River Basin) to quantify the relationships between habitat conditions and fish productivity (limiting factors) to improve the development and parameterization of models used in the planning and implementation of habitat projects. These studies will be coordinated with the influence of hatchery programs in these habitat areas.*

Fifty-four BPA projects were continued and three projects were initiated by BPA and Reclamation that have elements that support research in select areas of the pilot study basins (Wenatchee, Methow, and Entiat River basins in the upper Columbia River, the Lemhi and South Fork Salmon River basins, and the John Day River basin) to quantify the relationships between habitat conditions and fish productivity (limiting factors) and improve the development and parameterization of models used in the planning and implementation of habitat projects. These studies provide a means of evaluating the effectiveness of tributary mitigation actions. One of the

new projects was a funding placeholder to support additional intensively monitored watershed (IMW) studies.

In the Methow Basin, Reclamation has planned an intensive effectiveness monitoring program that will address the effects of actions intended to address the primary limiting factors there (lack of riparian/off-channel habitat and obstructions). This program will begin in 2009. Reclamation also conducted a series of meetings in 2007–2008 to finalize the Methow Study Plan. The study plan includes research on habitat limiting factors to fish production, and a Before, After, Control, Impact (BACI)-design study of a large channel rehabilitation project. An extensive PIT-tag array system will be constructed on all major tributaries and the main river of the Methow. Finally, Reclamation will provide PIT tags to the USFWS at the Winthrop National Fish Hatchery to tag and release large groups of hatchery fish, both to understand the potential effects of hatchery juveniles on stream-reared juvenile fish production and to use the releases to help estimate trap and detection efficiencies.

In addition, monitoring needed to infer relationships based on correlation among limiting factors, habitat actions, and productivity in support of RPA 3 (comprehensive evaluations) will also be addressed under RPAs 50.6 and 56.3.

2. *Implement habitat status and trend monitoring as a component of the pilot studies in the Wenatchee, Methow and Entiat river basins in the Upper Columbia River, the Lemhi and South Fork Salmon river basins, and the John Day River Basin. (Initiate in FY 2007-2009 Projects, annually review and modify annually to ensure that these project continue to provide a means of evaluating the effectiveness of tributary mitigation actions.)*

   Fourteen projects were continued and three were initiated that have elements that supported the implementation of habitat status and trend monitoring as a component of the pilot basin studies. For example, BPA project number 2000-031-00 documented changes resulting from restoration activities. Examples included changes in channel morphology, native plant communities, and floodplain function. This information will then be used to guide the project toward restoration strategies that provide the best opportunity for project success. All pilot basins except the Methow appear to have sufficient habitat status and trend monitoring, with no significant gaps. Habitat monitoring in the Lemhi, South Fork Salmon, and John Day focuses on specific limiting habitat factors. In contrast, habitat monitoring in the Wenatchee and Entiat focuses on a large suite of physical/environmental factors (64 indicators) that address water quality, habitat access, habitat quality, channel condition, riparian habitat condition, watershed condition, and flows. The Methow Basin level of habitat monitoring will be improved to address this RPA subaction.

3. *Facilitate and participate in an ongoing collaboration process to develop a regional strategy for limited habitat status and trend monitoring for key ESA fish populations. This monitoring strategy will be coordinated with the status monitoring needs and strategies being developed for hydropower, habitat, hatchery, harvest, and estuary/ocean.*

   Collaboration work groups for fish population and tributary habitat monitoring were formed in late 2008 and continue to make progress in 2009 on a regional monitoring strategy that includes fish population and habitat monitoring for at least one population per major population group.

RPA Action 57 – Evaluate the Effectiveness of Tributary Habitat Actions

The Action Agencies will evaluate the effectiveness of habitat actions through RME projects that support the testing and further development of relationships and models used for estimating habitat benefits. These evaluations will be coordinated with hatchery effectiveness studies.

1. *Action effectiveness pilot studies in the Entiat River Basin to study treatments to improve channel complexity and fish productivity.*

   BPA project numbers 2002-061-00 and 2003-017-00 were continued to support action effectiveness pilot studies in the Entiat River basin to study treatments to improve channel complexity and fish productivity. The RME Work Group recommended several habitat actions identified for implementation in the Entiat to support the RME projects.

2. *Pilot study in the Lemhi River Basin to study treatments to reduce entrainment and provide better fish passage flow conditions.*

   Six BPA projects were continued to fully address the pilot study in the Lemhi River basin to study treatments to reduce entrainment and provide better fish passage flow conditions. For example, BPA project number 1989-098-00 provided point estimates of adult escapement based on redd counts in nine study streams without weirs: Brushy Fork Creek, Marsh Creek, Alturas Lake Creek, White Cap Creek, the American River, Big Flat Creek, Colt Killed Creek, the North Fork Salmon River, and the Lemhi River. Also provided were bounded estimates of adult escapement to spawning areas in streams with weirs based on mark recapture estimates, and estimates of redd production attributable to natural, supplementation, and general production hatchery strays in six streams with weirs: Crooked Fork Creek and the South Fork Salmon, Pahsimeroi River, Red, Crooked, and upper Salmon rivers. Point estimates of general production hatchery stray rates into study streams were based on carcass recoveries in 13 streams where ground surveys were conducted, in Big Flat Creek, Brushy Fork Creek, Crooked Fork Creek, Marsh Creek, the Pahsimeroi River, the upper Salmon River, Colt Killed Creek, and the North Fork Salmon, Lemhi, South Fork Salmon, American, Crooked, and the Red rivers. These data are incorporated into annual progress reports and maintained in program databases. Adult escapement data into the East Fork Salmon River is analyzed jointly with Shoshone-Bannock Tribe cooperators and IDFG personnel from BPA project number 1997-001-00.

3. *Action effectiveness pilot studies in Bridge Creek of the John Day River Basin to study treatments of channel incision and its effects on passage, channel complexity, and consequentially fish productivity.*

   Six BPA projects were continued to fully support action effectiveness pilot studies in Bridge Creek of the John Day River Basin to study treatments of channel incision and its effects on passage, channel complexity, and consequentially fish productivity. For example, BPA project number 2002-074-00 collected habitat data to help evaluate project effectiveness and whether all implementation goals have been met. Protocols for data collection follow monitoring plans developed by the Clearwater National Forest and the Nez Perce Tribe (Department of Fisheries Resources Management, Watershed Division). Raw data on culverts are available through spatial links on the Nez Perce website. Data collected included channel grade in and out of the culvert, percent substrate colonization inside the structures, channel cross-sections inside and outside the culvert, and redd counts above culverts for fluvial bull trout and spring Chinook. Culverts are monitored before installation, immediately after installation, and then during the first, second, and fifth year after replacement.

4. *Project and watershed level assessments of habitat, habitat restoration and fish productivity in the Wenatchee, Methow and John Day basins.*

   Eleven BPA projects were continued and four were initiated to support project- and watershed-level assessments of habitat, habitat restoration, and fish productivity in the Wenatchee, Methow, and John Day basins. For example, BPA project number 1994-042-00 analyzed data to determine the timing and size of adult summer steelhead escapement, hatchery/wild component. The study also used data from PIT tags and smolt data to analyze out-migrant population estimates, travel

time and survival rates to Bonneville Dam, and timing and ocean survival for returning adults. BPA project number 2007-397-00 collected data for use in environmental compliance documents, the matrix of pathways, and biological objectives.

Reclamation continued its work through an interagency agreement with USGS to evaluate listed *O. mykiss* population changes in response to barrier removals in Beaver, Libby, and Gold creeks, which are tributaries in the Lower Methow River.

Reclamation's Methow RME Study Plan under an interagency agreement with USGS (see RPA 56 above) is aimed at evaluating the effectiveness of the M2 Reach habitat improvement actions in the mainstem Methow River. Reclamation's 2008 BiOp habitat program provides technical assistance to a suite of partners to help implement habitat improvement projects as defined by RPA Actions 34 and 35.

In 2008, Reclamation and USGS developed the pretreatment phase of the project; this is designed to address specific questions about the response of target fish species (Chinook salmon, steelhead, and bull trout) to the restoration actions, including the pretreatment phase, which will begin in the summer of 2009. Meanwhile, Reclamation and USGS worked on models to predict the response to treatment.

5. *Action Agencies will convene a regional technical group to develop an initial set of relationships in FY 2008, and then annually convene the group to expand and refine models relating habitat actions to ecosystem function and salmon survival by incorporating research and monitoring results and other relevant information.*

The Tributary Habitat and Fish Population Work Group met several times beginning in early 2008 to evaluate survival models. The technical group will build on current habitat capacity/population productivity life-cycle modeling methods to develop a systematic approach to estimating the freshwater survival benefit of basinwide restoration actions.

Reclamation funded NWFSC IA 1425-06-AA-1C-4806 to develop a landscape analysis model in 2004 using satellite imagery. Following the results of that work, in 2007 Reclamation provided technical leadership through PNAMP to help develop and fund a major regional effort to classify past and present salmon habitat using satellite imagery through an interagency agreement with the NOAA Fisheries Northwest Fisheries Science Center (NWFSC). In 2008, project staff developed geographical information system (GIS) data layers for several natural landscape characteristics associated with salmon production, for the 8,438 subwatersheds (12-digit HUCs) in the Pacific Northwest. They developed metrics of these landscape features for each subwatershed, eventually settling on eight variables.

RME Strategy 4 (RPA Actions 58–61)

A comprehensive list of all actions implemented by the Action Agencies for RPAs 58 through 61 is included in Section 4. Most of these RPAs' requirements either were fully covered by ongoing projects or would be fully covered with some additional work elements. Included after the RPA 61 description, below, is a synopsis of 2008 estuary and ocean RME results.

RPA Action 58 – Monitor and Evaluate Fish Performance in the Estuary and Plume

The Action Agencies will monitor biological responses and/or environmental attributes, and report in the following areas:

1. *Monitor and evaluate smolt survival and/or fitness in select reaches from Bonneville Dam through the estuary.*

Two Corps AFEP projects were continued to support the requirements of this subaction. For example, the AFEP Project EST-02-01, A Study of Salmonid Survival and Behavior through the

Columbia River Estuary Using Acoustic Tags, directly addressed this RPA. During 2008, more than 15,000 juvenile salmon were tagged with miniaturized acoustic transmitters, released at several sites upstream of Bonneville Dam, and detected at seven acoustic telemetry arrays deployed across the lower Columbia River and estuary at locations ranging from the Bonneville Dam tailrace to the jetties at the mouth of the Columbia River. Data from the study were used to estimate survival rates of yearling and subyearling Chinook salmon and steelhead in various reaches of the lower river and estuary during 2008. To fully address this subaction, the RME Work Group recommended assessing the applicability and the feasibility of measuring the fitness of juvenile salmon at select locations in the lower Columbia River and estuary under AFEP project EST-09-P-0, or a new project.

2. *Develop an index and monitor and evaluate life history diversity of salmonid populations at representative locations in the estuary.*

Four projects were continued by the Action Agencies to fully address this subaction. For example, planning within the AFEP process was initiated during 2008 for Project EST-09-P-NEW, Evaluation of Life History Diversity, Habitat Connectivity, and Survival Benefits Associated with Habitat Restoration Actions in the Lower Columbia River and Estuary. This project was initiated in part to address RPA Action 58.2. The need for and objectives of a project to meet this RPA subaction were included in the fiscal year 2009 AFEP planning process during 2008.

3. *Monitor and evaluate juvenile salmonid growth rates and prey resources at representative locations in the estuary and plume.*

In 2008, six projects were continued to fully address the RPA subaction. For example, in BPA projects 1998-014-00, Ocean Survival of Salmonids, and 2003-010-00, Historic Habitat Opportunities and Food-Web Linkages, data were collected on juvenile salmon growth and prey resources during cruises along transects in the nearshore ocean and plume, research was conducted in estuarine wetlands. Data from these studies and others were used to assess how environmental effects in the estuary and ocean affect juvenile salmon survival and adult return rates.

4. *Monitor and evaluate temporal and spatial species composition, abundance, and foraging rates of juvenile salmonid predators at representative locations in the estuary and plume.*

Two projects were continued to fully support this subaction for foraging rates. For example, BPA project 1998-014-00, Ocean Survival of Salmonids, addressed the plume component of this RPA subaction. The estuary component was addressed through several projects that focused on avian and piscivorous predators. Additional results are presented in the predation RPAs 68-70, below. Annual surveys of predation on juvenile salmon were conducted. Data showed the most common predators and, in some cases, led to estimates of predation rates.

RPA Action 59 – Monitor and Evaluate Migration Characteristics and Estuary/Ocean Conditions

The Action Agencies will monitor and evaluate selected ecological attributes of the estuary, which include the following or equivalent:

1. *Map bathymetry and topography of the estuary as needed for RME.*

Six projects were continued to fully address this subaction for mapping the channel; however, a gap exists until the bathymetry and topographic mapping are completed for the floodplain. For example, BPA project number 2003-007-00, Lower Columbia River/Estuary Ecosystem Monitoring, was pivotal to work throughout the estuary during 2008 to address this RPA subaction. Numerous other projects collected site-scale elevation data. Light detection and ranging (LIDAR) data for

topography were processed for selected sites under AFEP Project EST-02-P-04, Cumulative Effects of Habitat Restoration. Based on bathymetric data gaps identified and prioritized at a workshop in October 2007, NOAA collected bathymetry data to update nautical charts in the lower river and estuary in 2008 up to the Greater Portland/Vancouver area. Because these data did not cover shallow areas (less than 2 meters), additional measurements were contracted.

2. *Establish a hierarchical habitat classification system based on hydrogeomorphology, ground-truth it with vegetation cover monitoring data, and map existing habitats.*

   In 2008, two projects were continued to address this RPA subaction, which was a primary objective of BPA project number 2003-007-00, Lower Columbia River/Estuary Ecosystem Monitoring. Development of the classification system continued during 2008. Expanded work is expected in BPA project number 2003-007-00 to complete the remaining six or more reaches and develop input data for the classification (such as vegetative land cover) through implementation of a new project.

3. *Develop an index of habitat connectivity and apply it to each of the eight reaches of the study area.*

   Five projects were continued and initiated to fully address this RPA subaction. For example, planning within the AFEP began in 2008 for Project EST-09-P-NEW, Evaluation of Life History Diversity, Habitat Connectivity, and Survival Benefits Associated with Habitat Restoration Actions in the Lower Columbia River and Estuary. This project was initiated in part to address RPA Action 59.3. The need for and objectives of a project to meet this RPA subaction were included in the fiscal year 2009 AFEP planning process during 2008.

4. *Evaluate migration through and use of a subset of various shallow-water habitats from Bonneville Dam to the mouth toward understanding specific habitat use and relative importance to juvenile salmonids.*

   One Corps project was continued and another one was initiated to fully address this RPA subaction. For example, three projects involved study of juvenile salmon in various shallow-water habitats from Bonneville Dam to Astoria: the AFEP Project EST-02-01 (A Study of Salmonid Survival and Behavior through the Columbia River Estuary Using Acoustic Tags), BPA project number 2003-010-00 (Historic Habitat Opportunities and Food-Web Linkages), and BPA project number 2005-001-00 (Estuary RME Tidal Freshwater). As determined from beach seines and trap nets, juvenile salmon can be found year-round in the shallow waters of the lower river and estuary. The data increased understanding of specific habitat use and the relative importance of these habitats to juvenile salmon.

5. *Monitor habitat conditions periodically, including water surface elevation, vegetation cover, plan community structure, primary and secondary productivity, substrate characteristics, dissolved oxygen, temperature, and conductivity, at representative locations in the estuary as established through RME.*

   Nine projects were continued to address this RPA subaction. For example, the BPA project number 2003-007-00, Lower Columbia River/Estuary Ecosystem Monitoring, monitored habitat conditions at four sites in the reach between Bonneville Dam and Washougal, Washington. Monitored indicators included vegetation composition, percent cover, elevation, substrate, channel cross-sections, and water quality. The data characterized relationships among plant communities, elevation, and hydrology that help in understanding the ecological importance of lower river and estuary habitats.

RPA Action 60 – Monitor and Evaluate Habitat Actions in the Estuary

The Action Agencies will monitor and evaluate the effects of a representative set of habitat projects in the estuary, as follows:

1. *Develop a limited number of reference sites for typical habitats (e.g., tidal swamp, marsh, island, and tributary delta to use in action effectiveness evaluations).*

   Four projects were continued to fully address this RPA subaction. For example, BPA project number 2003-011-00, Lower Columbia River/Estuary Habitat Restoration, included a component to evaluate reference sites as part of action effectiveness monitoring in the lower Columbia River and estuary. Data were collected from four sites during 2008 to assess the structure, function, and condition of a suite of tidal freshwater wetland habitats. These will be used to compare restoration and reference sites to determine the effectiveness of habitat restoration (related to RPAs 60.2 and 60.3).

2. *Evaluate the effects of selected individual habitat restoration actions at project sites relative to reference sites and evaluate post-restoration trajectories based on project-specific goals and objectives.*

   Ten projects were continued to fully address this RPA subaction. For example, site-scale restoration effectiveness monitoring took place under multiple projects, such as BPA project number 2003-011-00, Lower Columbia River/Estuary Habitat Restoration. This project intensively monitored water surface elevation, bathymetry and topography, substrate, vegetation composition and percent cover, and juvenile salmon density at three sites where tidal reconnections were restored: Mirror Lake, Scappoose Bottomlands, and Fort Clatsop. This and other projects showed that juvenile salmon typically access the newly restored areas once the opportunity is provided.

3. *Develop and implement a methodology to estimate the cumulative effects of habitat conservation and restoration projects in terms of cause-and-effect relationships between ecosystem and controlling factors, structures, and processes affecting salmon habitats and performance.*

   Six projects were continued to fully address this RPA subaction, which was the primary focus of AFEP Project EST-02-P-04, Evaluating Cumulative Ecosystem Response to Habitat Restoration Projects in the Lower Columbia River and Estuary. The goal of this multi-year project (2004-2010) is to develop and apply a methodology to evaluate the cumulative effects of multiple habitat restoration projects. These projects are intended to benefit ecosystems that support juvenile salmon in the lower Columbia River and estuary. During 2008, the levels-of-evidence approach and ecological theory underpinning the analysis, synthesis, and evaluation of cumulative effects were finalized, and a preliminary analysis of restoration cumulative effects was initiated.

RPA Action 61 – Investigate Estuary/Ocean Critical Uncertainties

The Action Agencies will fund selected research direct at resolving critical uncertainties that are pivotal in understanding estuary and ocean effects.

1. *Continue work to define the ecological importance of the tidal freshwater, estuary, plume, and nearshore ocean environments to the viability and recovery of listed salmonid populations in the Columbia River Basin.*

   Six projects were continued to address this RPA subaction. Implementation of this RPA subaction was organized by water body: tidal freshwater (BPA project number 2005-001-00, Estuary RME Tidal Freshwater), estuary (BPA project number 2003-010-00, Historic Habitat Opportunities and Food-Web Linkages), plume (BPA project number 1998-014-00, Ocean Survival of Salmonids); and nearshore ocean (BPA project number 2003-009-00, Canada-US Shelf Salmon Survival Study). Collectively, these multi-year projects and others investigated the relationships among

juvenile salmon condition, growth, and survival indicators. Data showed the importance of understanding factors affecting salmon populations over the entire salmon life cycle.

2. *Continue work to define the causal mechanisms and migration/behavior characteristics affecting survival of juvenile salmon during their first weeks in the ocean.*

   Three projects were continued to fully address this RPA subaction: AFEP Project EST-02-P-03 (Evaluation of the Relationship among Time of Ocean Entry, Physical, and Biological Characteristics of the Estuary and Plume Environment and Adult Return Rates), BPA project number 1998-014-00 (Ocean Survival of Salmonids), and BPA project number 2003-114-00 (Pacific Ocean Shelf Tracking [POST]). As an example, juvenile salmon were sampled with trawls as the fish moved between riverine and marine waters. Data on species, age class, abundance, stock origin, size, diet, etc. were collected to determine how juvenile salmon change as they move between environments.

3. *Investigate the importance of early life history of salmon populations in tidal fresh water of the lower Columbia River.*

   Seven projects were continued to fully address this RPA subaction. For example, BPA project numbers 2003-010-00, Historic Habitat Opportunities and Food-Web Linkages, and 2005-001-00, Estuary RME Tidal Freshwater, were particularly relevant to this RPA subaction. Monthly beach seine sampling showed that juvenile coho and Chinook salmon were present in shallow, tidal freshwater habitats in the lower Columbia River in the vicinity of the Sandy River delta during all seasons, including winter. Based on genetic analysis of stock of origin, possible source populations for these fish ranged from areas in the lower Columbia River to areas in the middle Columbia River and Snake River.

4. *Continue development of a hydrodynamic numerical model for the estuary and plume to support critical uncertainties investigations.*

   Four projects were continued to address this RPA subaction. For example, the hydrodynamic modeling was conducted under BPA project numbers 1998-014-00, Ocean Survival of Salmonids, and 2003-010-00, Historic Habitat Opportunities and Food-Web Linkages. Modelers worked to develop an advanced observatory for the Pacific Northwest coastal margin, including the Columbia River estuary and plume. CORIE served as the heart of the observatory with its modeling system, observation network, and cyber-infrastructure. Modeling was used to evaluate contemporary and future habitat changes caused by climatic and anthropogenic effects and to describe the temporal and spatial features of the Columbia River estuary and plume that are important for salmon in relation to ocean conditions.

Synopsis of 2008 Estuary and Ocean RME

Status and Trends Monitoring. NMFS (2008a) reported that "during 2008, the trend of cold ocean conditions, which started to become established in 2007, has continued. The fact that cold ocean conditions have now become well established bodes well for marine fish (especially salmon) and bird species, since many of them will almost certainly have a good recruitment year." NMFS's ocean ecosystem indicators (*http://www.nwfsc.noaa.gov/research/divisions/fed/oeip/a-ecinhome.cfm*) provide context critical to management decision-making in the Columbia basin.

Magie et al. (2009), operating a newly modified trawl with a "matrix" antenna designed to increase the detection rate of PIT-tagged fish in the Lower Columbia River at River Kilometer (RKM) 61-83, found mean survival rates from Lower Granite to Bonneville Dam during 2008 for yearling Chinook salmon and steelhead were 42 percent (SE = 3.7 percent) and 46 percent (SE = 1.5 percent), respectively. This sampling effort is significant because, since 1998, it has allowed survival estimation between John Day and Bonneville dams using PIT-tag detection data.

McMichael et al. (2008) reported that preliminary 2008 survival estimates from Bonneville Dam tailrace to the mouth of the Columbia River for yearling Chinook salmon averaged 0.785 (range = 0.65 to 0.94) and for subyearling Chinook salmon averaged 0.83 (range = 0.64 to 0.93). The largest loss appeared to occur in the lower 35 km of the river for yearlings and the lower 50 km for subyearling Chinook salmon. These data will support strategic management actions to reduce mortality rates for juvenile salmonids in the Lower Columbia River and estuary.

Jones et al. (2008) examined vegetation and elevation data collected at relatively undisturbed, emergent wetland sites throughout the Lower Columbia River and estuary. They found that vegetation species occurrence and distribution are highly variable between sites, although dominant species are similar; invasive species, such as reed canary grass and Indigo bush, are pervasive; and strong gradients occur along the river between reaches and from the river to off-channel sites. This monitoring provided important information on the condition of habitats supporting juvenile salmonids in the Lower Columbia River and estuary.

NOAA Fisheries analyzed salmonid whole body, stomach content, and bile samples for toxic contaminant concentrations. For juvenile Chinook salmon collected at Campbell Slough and Sandy Island in 2007, measurable concentrations of DDT and polycyclic aromatic hydrocarbons (PAHs) were found in stomach contents, indicating that prey resources are a likely contaminant uptake pathway for salmonids (Jones et al. 2008). Contaminants in the Lower Columbia River and estuary could affect recovery of listed salmonid populations in the Columbia basin.

Action Effectiveness Research. Diefenderfer et al. (2009) used a hydrodynamic model to experimentally examine the aggregate effects of establishing hydrological connections between a tidally influenced mainstem river and the floodplain—a prominent form of habitat restoration in the lower Columbia River and estuary. In this case, the yield of inundated floodplain habitat area from dike breaching conformed to a diminishing returns model. Optimization of dike-breach restoration programs can be improved by strategic determination of the spatial configuration and number of breaches.

Roegner et al. (2008) found that breaching caused an immediate return of full semi-diurnal tidal fluctuations to diked pastureland; most importantly, juvenile salmonids quickly expanded into this newly available habitat and used prey items presumably produced within marshes at the restored site. Based on size and the timing of hatchery releases, Roegner et al. concluded that most Chinook, chum, and coho salmon sampled in restored and reference sites were progeny from wild spawners. In addition, genetic data suggested that Chinook salmon originating outside the study area had migrated from the mainstem into shallow tidal freshwater habitats and were using restored wetland habitat. Increasing opportunity for juvenile rearing appears to benefit both wild populations and, for Chinook salmon at least, individuals from other watersheds.

Diefenderfer and Montgomery (2008) documented the role of large wood accumulations in forcing channel morphology in remnant Sitka spruce–dominated tidal freshwater wetlands (swamps) in the floodplain of the Lower Columbia River and estuary. On the basis of pool spacing and observed sequences of log jams and pools, tidal forested wetland channels were classified consistent with a forced step-pool channel type. This new classification for tidal systems provides a basis for restoration project design involving placement of large wood and development of pool habitats for aquatic species.

In summer 2008, the Lower Columbia River Estuary Partnership and its restoration partners implemented action effectiveness research at four sites. As an example, at the Fort Clatsop tidal reconnection project, salmonids were more abundant and diverse following restoration, with salmonid

species richness increasing from two to five (LCREP 2009). At the Sandy River Delta revegetation project, planting survival varied significantly between sites, and may be correlated with the number of site-preparation treatments and the overall duration of site preparation prior to woody plant installation (LCREP 2009). Action effectiveness research is essential to inform decision-makers on habitat restoration in the Lower Columbia River and estuary.

Judd et al. (2009) evaluated the ability to enhance distribution of eelgrass (*Zostera marina*) in the Lower Columbia River and estuary to serve as refuge and feeding habitat for juvenile salmon. They developed the first predictive maps of sites suitable for eelgrass and other submerged aquatic vegetation in the lower estuary of the Columbia River. Restoration and expansion of freshwater submerged aquatic vegetation should be considered in a comprehensive effort to restore habitats supporting juvenile salmonid rearing in the Lower Columbia River and estuary.

Critical Uncertainties Research. NMFS (2008b) stated, "to date, the principal focus of salmon recovery efforts in the Columbia River basin has been on habitat changes and passage problems caused by large dams. Recent studies by Center scientists and University of Washington collaborators, however, have shown that salmon recovery will require restoration of shallow, intertidal estuarine habitats that support juvenile salmon. Scientists also found that many juvenile salmon reside, feed, and grow for days or weeks within the same wetland channel and that young salmon feed heavily on insect species produced in wetland habitats."

During a year-long study of juvenile salmon ecology in shallow, tidal freshwater habitats in the Lower Columbia River and estuary in the vicinity of the Sandy River Delta, Sather et al. (2009) documented that juvenile Chinook and/or coho salmon were present at all types of tidal freshwater habitats sampled and were present during all months of the year. Genetic analysis revealed that unmarked juvenile Chinook salmon were primarily from the upper Columbia River summer/fall stock group, which includes individuals from both above and below Bonneville Dam. Snake River and Deschutes River fall run stock groups also were present in the study area. Regardless of sampling month or site of capture, the diets of juvenile Chinook salmon were generally dominated by aquatic insects. Shallow, tidal freshwater habitats can provide rearing areas for juvenile salmon migrating downstream from above Bonneville Dam.

Casillas (2009), reporting on the multidisciplinary study of juvenile salmon ecology in the Columbia River plume, noted that spring and early summer ocean conditions off the Pacific Northwest likely have a greater impact on the survival and growth of interior spring-run Chinook salmon than conditions later in the summer and fall, when conditions are more likely to affect the survival and growth of fall-run Chinook and coho salmon. The management implication is that ocean conditions during early ocean entry need to be taken into account when interpreting adult return data.

Burla et al. (2009) used simulations to study Columbia River plume variability at multiple temporal scales to address the question of whether the intra-seasonal variability in smolt-to-adult survival rates are related to conditions in the Columbia River plume when the juvenile migrants enter the ocean. Such modeling techniques could be used to inform future management decisions.

From sampling juvenile salmon and zooplankton off the outer coast of Vancouver Island during 2008, Trudel et al. (2009) concluded that "the relative survival of different stocks of salmon in the ocean will depend on where they migrate in the ocean, and that changes at the base of the food chain must be taken into consideration to understand the effects of ocean conditions on salmon growth, and hence, on salmon survival." Using empirical data as a foundation, preliminary modeling results indicate potential to inform harvest strategies and conservation measures for Columbia River salmon.

Welch et al. (2008) performed an acoustic telemetry study of hatchery spring Chinook salmon, releasing tagged fish in the hydrosystem and sampling on receiving arrays in the Lower Columbia River and estuary and continental shelf up to Alaska. The authors concluded that the data are "inconsistent with the theory that delayed mortality is expressed below Bonneville." This research could affect management decisions on the smolt transportation program.

RME Strategy 5 (RPA Action 62)

A comprehensive list of all actions implemented by the Action Agencies for RPA 62 is included in Section *4. For RPA 62, the RME Work Group concluded that many subaction requirements were fully addressed; however, some additional monitoring was recommended to supplement ongoing monitoring.*

RPA Action 62 – Fund Selected Harvest Investigations

The Action Agencies will fund selected harvest investigations linked to FCRPS interests:

1. *Evaluate the feasibility of obtaining PIT-tag recoveries between Bonneville and McNary dams to determine whether recoveries can help refine estimates of in-river harvest rates and stray rates used to assess adult survival rates.*

   Five projects were continued and two were initiated to fully address this RPA subaction. For example, BPA project number 2008-508-00 evaluated run timing and upstream migration mortality of adult Chinook and sockeye salmon and steelhead through PIT-tagging at Bonneville Dam. A companion project, BPA project number 2008-502-00, Increase Zone 6 Tribal Fishery Monitoring, improved the monitoring and catch sampling of the Zone 6 tribal fisheries by increasing the sample rates and employing additional data collection methods, including PIT tag technology.

2. *Evaluate methods to develop or expand use of selective fishing methods and gear.*

   Three projects were continued to fully address this RPA subaction. The Action Agencies support investigations of alternative gear and modifications to existing gear strategies for fisheries in the Columbia Basin. They support development of selective gear methods to reduce hatchery surpluses consistent with HSRG recommendations. BPA project number 2007-249-00, Evaluate Live-Capture Fishing Gear for Salmon, focuses on evaluating the feasibility and efficacy of various live-capture selective fishing gears to harvest hatchery-origin Chinook while protecting natural-origin Chinook. In 2008, this project tested beach seines, purse seines, and tooth-tangle nets in the mainstem Columbia below Chief Joseph Dam and in the mainstem and tributaries of the Okanogan River. This project has multi-year funding and will further test and evaluate impacts to existing gear in 2009 as well test a modified pontoon fishwheel in the mainstem Columbia.

   In addition to gear testing, selective fishing can involve modifications to time and area management. BPA project number 1993-060-00, Select Area Fisheries Enhancement, has investigated the use of off-channel terminal fishing locations in concert with hatchery rearing and acclimation protocols to offer commercial and sport fishers harvest opportunities even when conventional mainstem fisheries are severely constrained or eliminated because of ESA limitations.

3. *Evaluate post-release mortality rates for selected fisheries.*

   One project was continued to address this RPA subaction. BPA project number 2007-249-00, Evaluate Live-Capture Fishing Gear for Salmon project, incorporated monitoring protocols to assess fish condition after capture, holding, and release. Results of these evaluations are presented in the project's 2008 annual report. This is identified as a high-priority area by the RME Work Group.

4. *Support coded-wire tagging and coded-wire tag recovery operations that inform survival, straying, and harvest rates of hatchery fish by stock, rearing facility, release treatment, and location.*

Nine projects were continued and one was initiated to address this RPA subaction. BPA has funded the recovery and stock identification of coded-wire tags since the early 1980s. In 2008, four BPA-funded projects implemented recovery efforts in ocean and in-river fisheries as well as some limited spawning ground surveys. In addition, many hatchery O&M projects the Action Agencies fund contain resources directed toward the recovery and stock identification of coded wire tags. The RME Work Group encouraged additional sampling effort on the spawning grounds. This may require shifting some effort from the ocean fisheries to in-river monitoring. The RME Work Group also recommends that contracts include language to improve quality assurance/quality control (QA/QC), analysis, and data management.

5. *Investigate the feasibility of genetic stock identification monitoring techniques.*

Sixteen projects were continued and two were initiated to fully address this RPA subaction. For example, for Project 2008-907-00, the Genetic Assessment of Columbia River Stocks work, work began in 2008 to address single nucleotide polymorphism (SNP) discovery, genetic baseline expansion, genetic stock identification (GSI) to evaluate catch, and genetic stock identification of salmon and steelhead passing Bonneville Dam. These four projects are highly related because SNP markers are needed to complete species specific baselines, and these baselines are required to complete GSI for the ESA population diversity requirements to support viability risk assessments and the evaluation of the effects of actions on various populations.

RME Strategy 6 (RPA Actions 63–65)

A comprehensive list of all actions implemented by the Action Agencies for RPAs 63 through 65 is included in Section 4. For RPAs 63 through 65, the RME Work Group concluded that some subactions requirements were fully addressed; however, additional monitoring was recommended to supplement ongoing monitoring.

RPA Action 63 – Monitor Hatchery Effectiveness

The Action Agencies will continue to fund selected monitoring and evaluation of the effectiveness of Hatchery Actions. The evaluation of hatchery projects will be coordinated with the Tributary Habitat monitoring and evaluation program.

1. *Determine the effect that safety-net and conservation hatchery programs have on the viability and recovery of the targeted populations of salmon and steelhead. (Initiate in FY 2007–2009 Projects)*

Eleven projects were continued to address this RPA subaction. All ongoing BPA-funded safety-net and conservation program projects to implement RPAs 41 and 42 have monitoring and evaluation elements to evaluate effectiveness. In some cases, there is a separate project to monitor effects on the viability and recovery of targeted populations. For example, BPA project number 1990-005-00 was implemented to monitor and assesses straying of adult summer steelhead and Chinook salmon returns from the Umatilla subbasin hatchery program. In cooperation with the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), life history characteristics of hatchery-reared summer steelhead will be monitored, assessed, and compared to life history characteristics of naturally reared summer steelhead.

2. *Determine the effect that implemented hatchery reform actions have on the recovery of targeted salmon and steelhead populations.*

One project was continued to address this RPA subaction. There are currently no projects that appear to address this RPA for the Tucannon, Touchet, and Winthrop NFH steelhead programs. However, the USFWS is currently evaluating a means of implementing the reform

recommendations at Winthrop NFH, and WDFW is evaluating a means of implementing the reform recommendations for the Tucannon and Touchet programs. BPA project number 1989-098-00, the Salmon Studies Idaho Rivers project, was implemented to complete data analysis of brood year 2007 juvenile production by estimating the outmigration of naturally produced Chinook salmon collected in 2008 and 2009. The interim production comparison was completed, with products incorporated into annual progress reports.

RPA Action 64 – Investigate Hatchery Critical Uncertainties

1. *Continue to estimate the relative reproductive success of hatchery-origin salmon and steelhead compared to reproductive success of their natural-origin counterparts for ESA-listed spring/summer Chinook population in the Upper Grande Ronde, Lostine River, and Catherine Creek; listed spring Chinook in the Wenatchee River; and listed steelhead in the Hood River. Continue to fund the ongoing RRS feasibility study for Snake River fall Chinook to completion in 2009.*

   Six projects were continued to fully address this RPA subaction. In 2008, BPA continued to fund relative reproductive success (RRS) studies for listed spring/summer Chinook salmon in the upper Grande Ronde River, Lostine River, and Catherine Creek; for listed spring Chinook in the Wenatchee River; for listed steelhead in the Hood River; and for listed fall Chinook in the Snake River. For example, BPA project number 1988-053-04 funded the installation of five downstream migrant screw traps in the Hood River subbasin, and a mark and recapture program was implemented at the traps. The mark and recapture program is used to estimate numbers of pre-smolt and smolt steelhead and Chinook salmon moving past pre-defined locations in the subbasin. The program recorded numbers of non-supplemented species of anadromous and resident salmon caught at five downstream migrant screw traps located in this subbasin.

   The numbers are used to monitor the relative abundance of each species in the trap catch. BPA project number 1989-096-00 was implemented to collect tissues for genetic analysis. Data collection includes microsatellite genotyping, DNA sequencing, and other methods of examining and characterizing genetic variation within and among groups of salmon and steelhead. Data analyses included descriptive population genetic characterization for Tier 2 sites (gene-frequency monitoring), levels of variability, relative relationships among hatchery and wild populations, and changes in those parameters over time. Experimental design at other sites involves parentage analysis to document differences in reproductive success among hatchery fish, wild fish, and the progeny of captive parents.

2. *Determine if properly designed intervention programs using artificial production make a net positive contribution to recovery of listed populations.*

   Thirty-four projects were continued to fully address this RPA subaction. BPA project number 2003-060-00 conducted comparative genetic data analyses between and among all project samples by brood year. Temporal genetic variability within Snake River populations will be evaluated. Wild-origin adults from spawning grounds and other previous samples were sorted into single brood year samples (based on scale ages) and compared to same brood year wild juvenile samples and other brood year-specific project samples. The relative reproductive success of Snake River hatchery and wild fall Chinook was evaluated against the proportions of hatchery and wild fall Chinook estimated to be on upper Snake River spawning grounds. The estimates for origins and relative abundance of potential natural spawners were made from data collected annually at the Lower Granite Dam adult trap.

3. *In collaboration with the other entities responsible for steelhead mitigation in the Methow River, BPA will fund a new RRS study for ESA-listed steelhead in the Methow River. BPA will also fund a new RRS study for listed fall Chinook in the Snake River. NOAA Fisheries will provide technical assistance to the Action Agencies in development of conceptual study designs suitable for use by the Action Agencies in obtaining a contractor to implement the new studies.*

Four projects were implemented in 2008 to fully support Subaction 3 of RPA 64. For example, BPA project number 1989-098-00, the Salmon Studies in Idaho Rivers project, estimated overall survival to Lower Granite Dam using the SURPH model by life stage for juvenile Chinook salmon from ISS treatment and control streams based on PIT-tag detections at Lower Granite, Little Goose, and Lower Monumental dams on the Snake River and McNary Dam on the Columbia River. A video-type weir was installed and operated in Lake Creek. Net daily and maximum movements were analyzed to determine adult numbers. BPA project number 2007-403-00, the Idaho Spring Chinook Captive Propagation project, conducted research and collected data to evaluate behavioral characteristics of captively reared Chinook salmon and monitor anadromous Chinook salmon returns and redd development on the East Fork Salmon River and West Fork Yankee Fork. Genetic samples of juvenile Chinook salmon were collected to evaluate the spawning success of captively reared adults. Weirs were maintained to monitor anadromous Chinook migration in the East Fork of the Salmon River and to monitor spawning behavior of captively reared adults released to the study area in the East Fork of the Snake River.

NOAA Fisheries is expected to proved technical assistance to BPA in 2009 during development of targeted solicitations for the new RRS studies for listed Methow River steelhead and listed Snake River fall Chinook salmon.

RPA Action 65 – Investigate Hatchery Critical Uncertainties

The Action Agencies will fund research directed at resolving critical uncertainties:

1. *In the mainstem Snake River above the Lower Granite Dam, estimate the effectiveness/fitness in nature of hatchery-origin fall Chinook salmon from federally funded Snake River hatchery programs relative to natural origin Snake River fall Chinook.*

Three projects were continued and one was initiated to address this RPA subaction. For example, BPA project number 1998-010-03 funded PIT-tagging of hatchery spring Chinook salmon (brood year 2008) produced by the Lostine River Conventional Program to estimate the survival and arrival timing of the conventional stock of Lostine River hatchery Chinook salmon for migration year 2010. The project also documented the distribution of fall Chinook salmon redds in the 100-mile reach of the Snake River, between Asotin, Washington, and Hells Canyon Dam. Redd surveys were conducted from a helicopter at weekly intervals, between mid-October and mid-December. Also during this time period, submersible cameras were used to locate redds in waters too deep to be effectively searched from the air. BPA project number 1998-010-04, the Snake River Fall Chinook Spawning project, organized and implemented expanded spring Chinook redd counts and assessments in the Grande Ronde subbasin (Lostine, Catherine Creek, and upper Grande Ronde) and analyzed length and weight data for each Fall Chinook Acclimation Program (FCAP) release group. The RME Work Group identified this as a high-priority area to address in the future.

2. *Estimate fall Chinook hatchery program effects on the productivity of the fall Chinook salmon ESU.*

Three projects were continued and one was initiated to fully address this RPA subaction. In addition, the BPA projects associated with Subaction 1 of RPA 65 were implemented to support Subaction 2 by evaluating fall Chinook salmon productivity.

3. *NOAA Fisheries will provide technical assistance to the Action Agencies in development of conceptual study designs suitable for use by the Action Agencies in obtaining a contractor to implement new studies.*

   NOAA is expected to provide this technical assistance to BPA in 2009 during development of targeted solicitations for the new Snake River fall Chinook RRS study and any additional study or studies needed to estimate the effects of the fall Chinook hatchery program on productivity of the ESU.

4. *In the Methow River BPA will also fund a new RRS study for listed fall Chinook in the Snake River. NOAA Fisheries will provide technical assistance to the Action Agencies in development of conceptual study designs suitable for use by the Action Agencies in obtaining a contractor to implement the new studies.*

   This action is contingent upon completion of a federal RME work group analysis that is due in fall 2009.

RME Strategy 7 (RPA Actions 66–69)

A comprehensive list of all actions implemented by the Action Agencies for RPAs 66 through 69 is included in Section 4. For these RPAs, the RME Work Group concluded that most subactions were fully addressed; however, additional monitoring was recommended to supplement ongoing monitoring.

RPA Action 66 – Monitor and Evaluate the Caspian Tern Population in the Columbia River Estuary

One project was continued to fully address this RPA subaction. The Avian Predation on Juvenile Salmonids project, BPA project number 1997-024-00, provided for the monitoring of the Caspian tern colony on East Sand Island. Colony size, reproduction rates, diet composition, and predation rates were monitored to determine the effect of the colony on juvenile salmon. Results are discussed under RPA 45, above, and further reported at http://www.birdresearchnw.org. The Action Agencies also funded Caspian tern monitoring at the alternate habitat sites identified in the Caspian Tern Management Plan.

RPA Action 67 – Monitor and Evaluate the Double-Crested Cormorant Population in the Columbia River Estuary

One project was continued to fully address this RPA subaction. BPA project number 1997-024-00, the Avian Predation on Juvenile Salmonids project, provided for the monitoring of the double-crested cormorant colony on East Sand Island. Colony size, reproduction rates, diet composition, and predation rates are monitored in order to determine the effect of the colony on juvenile salmon. Results are discussed under RPA 45, above, and further reported at http://www.birdresearchnw.org.

The Action Agencies also are funding assessments of the population status of Pacific Coast double-crested cormorants, the availability of suitable alternative nesting habitat outside the Columbia River basin, and potential management approaches to decrease cormorant depredation of juvenile salmon in the Columbia River basin should management of cormorants be determined to be warranted.

RPA Action 68 – Monitor and Evaluate Inland Avian Predators

The Action Agencies will monitor avian predator populations in the Mid-Columbia River and evaluate their impacts on outmigrating juvenile salmonids and develop and implement a management plan to decrease predations rates, if warranted.

One project was continued to fully address this RPA subaction. BPA project number 1997-024-00, Avian Predation on Juvenile Salmonids, provided aerial surveys to identify any significant avian colonies located in the mid-Columbia. This includes colonies like the Caspian tern colony on Crescent Island and the double-crested cormorant colony on Foundation Island, which are monitored to determine their effects on juvenile salmon. Results are discussed under RPA 45, above, and further

reported at http://www.birdresearchnw.org. Research related to the Crescent Island Caspian tern and Foundation Island double-crested cormorant colonies is scheduled to be completed in 2009.

A meeting between the Action Agencies and the USFWS in 2008 addressed the development of an avian management plan for Corps-owned lands. The main objective of this management plan is to improve ESA-listed anadromous fish survival for fish rearing and migrating through the Lower Snake and Columbia rivers. (The development and implementation of avian management plan[s] continued in 2009.)

RPA Action 69 – Monitoring Related to Marine Mammal Predation

As part of RPA 69, the Corps continued to monitor sea lion predation at Bonneville Dam in 2008. For a more comprehensive summary of 2008 monitoring efforts, refer to the field report by Tackley et al. (2008).

1. *Estimate overall sea lion abundance immediately below Bonneville Dam. (Initiate in FY 2007-2009 Projects)*

   Two projects were continued to fully address this RPA subaction. From January 11 to May 31, 2008, the Corps continued to visually monitor the abundance of California sea lions below Bonneville Dam (Figure 17). In addition, a BPA-funded CRITFC project (BPA project number 2008-004-00) estimated general sea lion abundance while conducting in-river hazing on sea lions.

2. *Monitor the spatial and temporal distribution of sea lion predation attempts and estimate predation rates. (Initiate in FY 2007-2009 Projects)*

   Two projects were continued to fully address this RPA subaction. In 2008, the Corps continued land-based visual observations to monitor the expanded adult salmon catch estimate for the Bonneville Dam tailrace observation area. The Corps also monitored the date and location of individual sea lion predation attempts. The BPA-funded CRITFC project observed the total number of sea lion predation attempts and recorded their location and time.

   The expanded adult salmon catch estimate for the Bonneville Dam tailrace observation area was 2.9 percent (n=4,466) of the adult salmon run at Bonneville Dam from January 1 through May 31, 2008. The adjusted estimated catch was 3.2 percent of the run (n=4,927). California sea lions were the primary salmon predator, accounting for 96 percent (n=4,081) of the 4,243 observed catches. This percentage was lower than was seen in previous years, as observed salmon catch by Steller sea lions increased from 0.3 percent (n=12) in 2007 to 3.8 percent (n=162) of total take in 2008 (see Table 8).

   Chinook salmon were the most commonly identified prey species, making up about 93 percent (n=3,955) of observed adult salmon catch in 2008. The expanded Chinook catch estimate for the Bonneville Dam tailrace observation area was 2.3 percent (n=4,115) of the Chinook run through June 15, 2008. Note that this time period differs from the passage season used for total salmon estimates. This period includes the Columbia River spring Chinook passage season at Bonneville Dam, which extends beyond the period during which sea lions are present. Steelhead made up about 6.8 percent (n=288) of observed adult salmon catch during the same period. Steelhead, which are present in the Bonneville Dam tailrace throughout the winter and spring, made up the majority of salmon catches the spring Chinook salmon run began. Of the total pinniped catch for 2008, California sea lions took 96.1 percent of the Chinook and 96.9 percent of the steelhead (see Table 9).

   Physical barriers, including SLEDs and floating orifice gate (FOG) barriers, apparently prevented sea lions from entering the fishways, but acoustic deterrents installed near fishway entrances continued to have no visible effect on sea lions. During daylight hours, dam-based USDA Wildlife

Services agents contracted by the Corps, and boat-based crews from ODFW, WDFW, and CRITFC used non-lethal pyrotechnics and rubber bullets to harass sea lions in the dam tailrace. Harassment appeared to temporarily alter the behavior of some sea lions but did not reverse the upward trend in predation estimates.

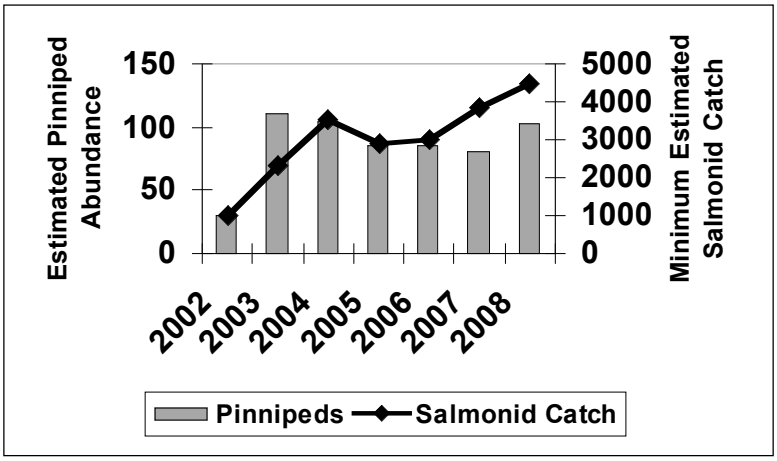

Figure 9. Estimated Minimum Number of Adult Salmonids Consumed by Pinnipeds and Estimated Total Number of Pinnipeds Observed at Bonneville Dam, January 1–May 31, from 2002 to 2008.
Note: In 2005, regular observations did not start until March 18. Pinnipeds observed included California sea lions, Steller sea lions, and harbor seals.

Table 8. Bonneville Dam Salmonid Passage Catch Summary (2002–2008).

Year	Bonneville Dam Salmonid Passage (Jan. 1–May 31)	Observed Salmonid Catch		Expanded Salmonid Catch Estimate		Adjusted Salmonid Catch Estimate	
		Observed Catch	% of Run (1/1 to 5/31)	Estimated Catch	% of Run (1/1 to 5/31)	Estimated Catch	% of Run (1/1 to 5/31)
2002	284,733	448	0.2%	1,010	0.4%	—	—
2003	217,185	1,538	0.7%	2,329	1.1%	—	—
2004	186,804	1,324	0.7%	3,533	1.9%	—	—
2005	82,006	2,659	3.1%	2,920	3.4%	—	—
2006	105,063	2,718	2.5%	3,023	2.8%	3,401	3.1%
2007	88,474	3,569	3.9%	3,859	4.2%	4,355	4.7%
2008	147,543	4,243	2.8%	4,466	2.9%	4,927	3.2%

Note: Total salmonid passage counts include all adult salmonids that passed Bonneville Dam January 1–May 31. Expanded catch estimates account for hours and days not observed. Adjusted catch estimates include expanded catch estimates and some unidentified catches, which were allocated based on the distribution of identified catches. Observed catch is raw actual observed catch/consumed and excludes about 2 percent of catch and subsequent lost fish (swimming away alive). Estimated catch is the expanded catch for hours and days not observed.

Table 9. California Sea Lion 2008 Catch Estimates: Chinook vs. Steelhead.

	Percent of Total Pinniped Catch Taken by California Sea Lions	Expanded Catch Estimate (California sea lions)
Chinook	96.1%	3955
Steelhead	96.9%	340

With funding from BPA, ODFW and WDFW used four floating sea lion traps deployed along the PH2 corner collector to capture California sea lions. The sea lions were then weighed, branded and released, or transferred to aquariums. Of the 11 California sea lions trapped in 2008, six were sent to aquariums, four were processed (measured, weighed, and marked with a three-digit brand) and released; one died under anesthesia before it could be sent to an aquarium. In May 2008, four California sea lions and two Steller sea lions died on traps; this halted trapping operations for the 2008 season.

RME Strategy 7 (RPA Action 70)

A comprehensive list of all actions implemented by the Action Agencies for RPA 70 is included in Section 4. For RPA 70, the RME Work Group concluded that the subactions were fully addressed.

RPA Action 70 – Monitoring Related to Piscivorous (Fish) Predation

1. *Continue to update and estimate the cumulative benefits of sustained removals of northern pikeminnow since 1990.*

   One project was continued to fully address this RPA subaction. The Northern Pikeminnow Management Program (NPMP), BPA project number 1990-07-700, contains an extensive biological evaluation component implemented primarily by the Oregon Department of Fish and Wildlife. This program component annually collects and validates biological field data and updates the benefit model with the latest year's data.

2. *Continue to evaluate if inter and intra compensation is occurring.*

   One project was continued to fully address this RPA subaction. The evaluation of the NPMP annually assesses whether compensation is occurring as a result of cumulative removals to date. The program evaluation showed no indication of compensation by smallmouth bass, walleye or channel catfish.

3. *Evaluate the benefit of additional removals and resultant increase in exploitation rate's affect on reduction in predator mortality since the 2004 program incentive increase.*

   One project was continued to fully address this RPA subaction. Exploitation rates since the implementation of the monetary incentive increase in 2004 have significantly exceeded the average exploitation rate of the previous 14 years. A significant increase and resultant benefit have been observed since the monetary incentive program was increased in 2004. Some of this may be a result of additional tagging research and the validation of annual tag loss estimates.

4. *Develop a study plan to review, evaluate, and develop strategies to reduce non-indigenous piscivorous predation.*

   BPA sponsored project number 2008-720-00,Workshop Non-Indigenous Fishes, that supported a one-day workshop entitled "Review, Evaluate, and Develop Strategies to Reduce Non-Native Piscivorous Predation on Juvenile Salmonids" on September 24, 2008. Results and follow-up topic areas were compiled and presented to NOAA Fisheries. Additional work on development of strategies will continue in 2009 and beyond.

RME Strategy 8 (RPA Actions 71–72)

A comprehensive list of all actions implemented by the Action Agencies for RPAs 71 and 72 is included in Section 4. For these RPAs, the RME Work Group concluded that most subaction requirements were fully addressed; however, additional monitoring coordination and data management were recommended to supplement ongoing monitoring in the future.

RPA Action 71 – Coordination

The Action Agencies will coordinate RME activities with other Federal, State and Tribal agencies on an ongoing annual basis.

1. *Organizing and supporting the Corps AFEP.*

   The Corps of Engineers has, since 1952, sponsored biological studies in an integrated, applied research program. These monitoring, research, and evaluation studies are managed under the Anadromous Fish Evaluation Program (AFEP).

   In 2008, the Corps again implemented the AFEP program. As usual, one of the major activities was the selection and development of experimental design and methodology of research projects to be carried out in 2009. This process was extensively coordinated with other federal agencies, states, and tribal interests through their involvement in the Studies Review Work Group (SRWG), which met several times through the year. In December 2008, a 4-day annual review, open to all interested parties, was held to present the results of AFEP research carried out during the year.

   The AFEP program also includes the Fish Facility Design Review Work Group (FFDRWG) and the Fish Passage Operations and Maintenance (FPOM) work group. The FFDRWG provides ongoing review of fish facility design activities. The FPOM work group provides ongoing review of operational activities related to fish passage. All federal, state, and tribal fishery agencies are invited to participate in FFDRWG meetings and FPOM meetings, both of which generally occur monthly.

   Further information on the AFEP program, and on the research carried out in 2008 and planned for 2009, is available at *http://www.nww.usace.army.mil/planning/ep/fishres/afep-default.htm* and *http://www.nwp.usace.army.mil/pm/e/afep_docs.asp*

2. *Supporting and participating in the Council's Columbia River Basin Fish and Wildlife Program project planning and review efforts.*

   BPA continued to work with Northwest Power and Conservation Council staff in coordinating its Fish and Wildlife Program's project planning and review efforts.

3. *Supporting the standardization and coordination of tagging and monitoring efforts through participation and leadership in regional coordination forums such as PNAMP.*

   Five projects were continued to fully support this subaction. For example, BPA project numbers 1994-033-00, 1996-020-00, 1996-043-00, and 2004-002-00 were implemented to support RPA Action 71.3. The PNAMP funding (BPA project number 2004-002-00) supported this RPA action by coordinating the PNAMP Tagging and Telemetry Monitoring project to evaluate tagging and telemetry work and make recommendations on field protocols and methods for fish tagging and telemetry field data collection techniques. The Fish Passage Center (Project 1994-033-00) supported the evaluation and synthesis of fish passage of tagged fish through the hydropower system.

   Reclamation directly participated in PNAMP by providing full-time equivalents (FTE) for the PNAMP steering committee, and by continuing to provide funding for its two coordinators and database expert. Reclamation provided technical expertise for two major PNAMP tasks issued by the Northwest Environmental Information Sharing (NWEIS) executive forum, including development of a white paper on high-level indicators and planning for a regionwide data dictionary.

4. *Working with regional monitoring agencies to develop, cooperatively fund, and implement standard metrics, business practices, and information collection and reporting tools needed to cooperatively track and report on the status of regional fish improvement and fish monitoring projects.*

   Eleven BPA projects were continued and two were initiated to address this subaction. For example, BPA project number 2003-007-00, the Lower Columbia River Estuary Ecosystem Monitoring project, compiled data essential for coordination of efforts from entities that are systematically monitoring the lower Columbia River estuary. This project also supported regional and scientific expert participation in a monitoring subcommittee of the Science Work Group that will meet regularly to discuss ongoing monitoring programs. The work group is working to coordinate data collection efforts and data comparability for data collection gaps, eliminate duplication of efforts, and promote the comparability of methods, data management, and improvement of existing monitoring.

   The information collected through these meetings and from the staff of the Lower Columbia River Estuary Partnership and Pacific Northwest National Laboratory (PNNL) was compiled into a central database and then mapped by the Estuary Partnership. The Okanogan Basin Monitoring and Evaluation Program, BPA project number 2003-022-00, was developed under a regional M&E scheme involving coordination with multiple entities to ensure that all M&E efforts are compatible throughout the Columbia Basin and the region. The Okanogan Basin Monitoring and Evaluation Program uses a GRTS EMAP sampling design provided by the EPA to assess habitat conditions. Under this sampling design, 150 sampling sites (90 U.S., 60 Canadian) were randomly selected throughout the Okanogan watershed. The RME Work Group identified multiple areas where monitoring coordination and data sharing could be improved.

5. *Coordinating the further development and implementation of Hydrosystem, Tributary Habitat, Estuary/Ocean, Harvest, Hatchery, and Predation RME through leadership and participation in ongoing collaboration and review processes and workgroups.*

   Five BPA projects were continued to fully support this RPA subaction. For example, the Bioanalyst Technical Support project (BPA project number1996-017-00) provided technical and analytical support to BPA and other federal agencies for compliance under the ESA, National Environmental Policy Act (NEPA), and Northwest Power Act by conducting quantitative analyses, participating in regional technical/analytical forums, assisting in development of biological models, performing QA/QC for data sets, and preparing technical reports on selected topics.

   The Estuary and Ocean RME Support project (BPA project number 2002-077-00) continued facilitation and coordination of the RME estuary and ocean subgroup (EOS), provided staff time, developed monitoring inventories for the RME gap assessment, and coordinated the estuary RME work with the developing data management effort for the basinwide RME.

6. *Coordinating implementation with other appropriate regional collaboration processes. This includes coordination related to statutory provisions for the Federal government (BPA/Council), voluntary coordination among Federal agencies (Federal Caucus), and coordination with regional processes for Federal/non-Federal engagement (Technical Management Team (TMT), System Configuration Team (SCT), PNAMP, Northwest Environmental Data- Network (NED), and others.*

   Four BPA projects were continued and two were initiated to fully support this subaction. For example, BPA project numbers 2004-002-00, 2002-077-00 and 2003-072-00 were implemented to support regional collaboration processes. The PNAMP Funding project (BPA project number 2004-002-00) provided funds for full-time staff support at PNAMP to facilitate and organize regional collaboration efforts on monitoring techniques and data management. The Estuary and Ocean RME Support project (BPA project number 2002-077-00) continued facilitation and coordination of the RME EOS subgroup to participate in regional monitoring collaboration with PNAMP. The Action Agencies plan to continue to participate in and support these processes and products, including the current Action Agency, NOAA, and NPCC work group collaboration on implementation planning, annual/comprehensive progress reporting, and adaptive management of RME strategies.

RPA Action 72 – Data Management

The Action Agencies will ensure that the information obtained under the auspices of the FCRPS RME Program is archived in appropriate data management systems.

1. *Continue to work with regional Federal, State and Tribal agencies to establish a coordinated and standardized information system network to support the RME program and related performance assessments. The coordination of this development will occur primarily through leadership, participation, and joint funding support in regional coordination forums such as the NED workgroup, and PNAMP and the ongoing RME pilot studies in the Wenatchee River, John Day River, Upper Salmon River, and Columbia River Estuary. (Initiate in FY 2007- 2009 Projects)*

   Nine BPA projects were continued and three were initiated to fully support this subaction. For example, BPA project numbers 1982-013-01, 1988-108-04, 1998-031-00, 2003-036-00, and 2008-505-00 were implemented to support development of a coordinated and standardized information management network. The StreamNet (CIS/NED) project (BPA project number 1988-108-04) supported participation in planning, development, and/or coordination meetings with regional projects and programs under the Northwest Power and Conservation Council's Fish and Wildlife Program to help develop a regional data management framework, to establish data type and data service priorities, and to provide advice in the area of data management, as requested. The StreamNet project also supported participation in coordination groups (the Columbia Basin Fish and Wildlife Authority, for example), advisory groups, task forces, and other groups (such as PNAMP, NED, and CSMEP) whose purpose is to enhance the effectiveness of the Fish and Wildlife Program relative to its data development activities.

   Reclamation supported ongoing regional RME coordination through the PNAMP (see *www.pnamp.org* for information on PNAMP's 2008 accomplishments), completion of a major database to catalog monitoring protocols (Protocol Manager), and the transfer of that technology to a NOAA contractor to integrate protocols into a regionwide data dictionary that is being coordinated through PNAMP.

2. *Contribute funding for data system components that support the information management needs of individual Hydrosystem, Tributary Habitat, Estuary/Ocean, Harvest, Hatchery, and Predation RME. (Initiate in FY 2007-2009 Projects)*

   One project was continued and two were initiated to address this subaction. The StreamNet project (BPA project number 1988-108-04) coordinated the maintenance of the database portion of the Pacific Northwest Hydropower Database and Analysis System (NWHS). This task provided for communication and functional coordination and maintenance with, and assistance to, the Northwest Power and Conservation Council, BPA, Corps, and other federal agencies for NWHS-related development, maintenance, and review activities. This project also coordinated and performed the NWHS Database review, which involved retrieval, data item review and analysis, data record update, and completion to improve the quantity and quality of hydro site or project information. In addition, the project provided staff support to answer inquiries and assist users of NWHS**.** Additional recommendations for data stewards and technical support were identified by the RME Work Group.

3. *Participate in Northwest regional coordination and collaboration efforts such as the current PNAMP and NED efforts to develop and implement a regional management strategy for water, fish and habitat data. (Initiate in FY 2007-2009 Projects).*

   Five BPA projects were continued and three were initiated to fully support this subaction. For example, BPA project numbers 1988-108-04, 2004-002-00, and 1996-017-00 were implemented to support participation in coordination efforts to implement a regional data management strategy. For example, the PNAMP funding for BPA project number 2004-002-00 supported staff for

coordination or work sessions and regional collaboration discussion by the PNAMP Data Management Work Group to continue implementation of NED recommendations.

RME Strategy 9 (RPA Action 73)

RPA Action 73 – Implementation and Compliance Monitoring

The Action Agencies will use the project-level detail contained in the Action Agencies' Biological Opinion databases to track results and assess our progress in meeting programmatic level performance targets. This performance tracking will be reported through annual progress reports and the comprehensive reports scheduled for 2013 and 2016.

1. *Annually monitor the successful implementation of projects through standard procedures and requirements of contract oversight and management, and review of project deliverables and final reports.*

   The Action Agencies successfully implemented programs following government contracting requirements with quarterly and/or annual project implementation reporting. BPA implemented the Pisces program to track project implementation to support compliance and evaluations of project effectiveness.

2. *Maintain project and action level details for planning and reporting purposes. This approach will provide the most up-to-date information about the status of actions and projects being implemented.*

   BPA implemented the Pisces program to track project implementation for all projects and started development of the BPA Dashboard and Taurus program to track action implementation for the FCRPS RPAs. Reclamation continued to assess and plan for the inclusion of its implementation data into a coordinated Action Agency database.

3. *Maintain a comprehensive habitat project tracking system where relevant project information is contained in an accessible comprehensive data system. The data system will contain project level information that is needed for both implementation and effectiveness monitoring. The system will include the set of minimum metrics and metadata for RME data design listed in Data Management Needs for Regional Project Tracking to Support Implementation and Effectiveness Monitoring (Katz et al. 2006). (Initiate in FY 2008)*

   In addition to implementing the Pisces program on all BPA-funded projects, BPA implemented nine projects that tracked and compiled standardized environmental resource project tracking data that could support effectiveness monitoring evaluation efforts. In 2008, the implementation of Katz et. al (2006) metrics was initiated for Pisces but was delayed in order to ensure consistency with other NOAA Fisheries regional database tracking systems, which were in the process of validating Katz et al. metrics in the PCSRF program. For BPA, the Katz et. al. metrics will be tracked for fiscal year 2010, with the exception of those metrics that NOAA is in the process of updating. Additional work to further align tracking systems will continue in 2009.

   The Action Agencies have recorded project implementation and associated metric information for tributary habitat actions since implementation of tributary habitat actions became part of the FCRPS BiOp RPA in 2000. Examples of these data are presented in Section 4. These data currently are stored in the Pisces database for actions for which BPA provides funding and in a separate database for actions for which Reclamation provides technical assistance. Because these databases were developed in the early 2000s, they currently include only a subset of the metrics contained in Katz et al. (2006); however, most of these projects have already been integrated into the NOAA Pacific Northwest Salmon Habitat Restoration Project Tracking (PNSHP) database that is based on Katz et al. Further regional coordination by the Action Agencies on habitat implementation metrics is being pursued through PNAMP work groups.

References, Citations, and Sources of Data

The "Action Agencies" are the Army Corps of Engineers Northwestern Division, Bonneville Power Administration, and the Bureau of Reclamation Pacific Northwest Region.

In Text	Complete Title
ACOE 2008a	Army Corps of Engineers. February 2008. *Corps of Engineers Plan of Action for Dissolved Gas Monitoring in 2008*. Northwestern Division, Portland, OR.
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Acronyms, Abbreviations, and Glossary

The "Action Agencies" refers to Bonneville Power Administration, the U.S. Army Corps of Engineers, and the U.S. Bureau of Reclamation.

AFEP	Anadromous Fish Evaluation Program
AWS	auxiliary water system
BA	Biological Assessment
BACI	Before, After, Control, Impact
BGS	behavioral guidance screen
BiOp	Biological Opinion
BPA	Bonneville Power Administration
BRZ	Boat Restricted Zone
cfs	cubic feet per second
CIG	Climate Impacts Group, University of Washington; is developing climate change streamflows for the Columbia River basin
COP	Configuration and Operational Plan
Corps	U.S. Army Corps of Engineers
CREST	Columbia River Estuary Study Taskforce
CRFG	Columbia River Forecast Group, formed by the Action Agencies and Fish Accord partners
CRFM	Columbia River Fish Mitigation
CSS	Comparative Survival Study
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
DART	Data Access Real Time
EOS	estuary and ocean subgroup
EPA	U.S. Environmental Protection Agency
ERDC	Engineer Research and Development Center
ESA	Endangered Species Act
FCAP	Fall Chinook Acclimation Program
FCRPS	Federal Columbia River Power System
FFDRWG	Fish Facility Design Review Work Group
FGE	fish guidance efficiency
FOG	floating orifice gate
FOP	Fish Operations Plan
FPC	Fish Passage Center
FPOM	Fish Passage Operations and Maintenance
FPP	Fish Passage Plan
FTE	full-time equivalent
FWP	Fish and Wildlife Program
GBT	gas bubble trauma
GIS	geographical information system
GSI	genetic stock identification
HGMP	Hatchery Genetic Management Plan
HSRG	Hatchery Scientific Review Group
IDFG	Idaho Department of Fish and Game
IMW	intensively monitored watershed
ISAB	Independent Scientific Advisory Board
JBS	juvenile bypass system
JFF	juvenile fish facility

JSAT	Juvenile Salmonid Acoustic Tag
kaf	thousand acre-feet
kcfs	thousand cubic feet per second
ksfd	thousand second foot per day; k = kilo = thousand; ksfd = 1,000 cfs (cubic feet per second) per day. kfsd * 1.98347 = thousand acre-feet
LCREP	Lower Columbia River Estuary Partnership
LGR	Lower Granite Dam
LIDAR	light detection and ranging
LSRCP	Lower Snake River Compensation Plan
M&E	monitoring and evaluation
MAF	million acre-feet
MCE	minimum control elevation
MMPA	Marine Mammal Protection Act
MOP	minimum operating pool
NED	Northwest Environmental Data
NEPA	National Environmental Policy Act
NFH	National Fish Hatchery
NOS	natural-origin spawner
NPCC	Northwest Power and Conservation Council
NPMP	Northern Pikeminnow Management Plan
NTS	non-treaty storage
NWEIS	Northwest Environmental Information Sharing
NWFSC	Northwest Fisheries Science Center
NWH	Northwest Hydropower Database and Analysis System
O&M	operations and maintenance
ODFW	Oregon Department of Fish and Wildlife
PAHs	polycyclic aromatic hydrocarbons
PH2	second powerhouse
PNAMP	Pacific Northwest Aquatic Monitoring Partnership
PNSHIP	Pacific Northwest Salmon Habitat Restoration Project Tracking
POST	Pacific Ocean Survival Tracking Project
PS	performance standard
PTAGIS	PIT-Tag Information System
QA/QC	quality assurance/quality control
Reclamation	U.S. Bureau of Reclamation
RKM	river kilometer
RM	river mile
RME	research, monitoring, and evaluation
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
RRS	relative reproductive success
RSW	removable spillway weir
SAR	smolt-to-adult return
SLED	sea lion exclusion device
SNP	single nucleotide polymorphism
SOS	System Operation Request
SRWG	Studies Review Work Group
STS	submersible traveling screen

TDG	total dissolved gas
TIE	turbine intake extension
TMDL	total maximum daily load
TMT	Technical Management Team
TSW	top-spill weir
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VARQ	variable outflow flood control procedures
VBS	vertical barrier screen
VSP	viable salmonid population
WDFW	Washington Department of Fish and Wildlife
WDOE	Washington Department of Ecology
WMP	Water Management Plan
YN	Yakama Nation